ANNUAL MAINTENANCE NUMBER

In this Issue

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DEC.

NIGHT FIGHTER

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AVIATION

Established 1916

OLDEST AMERICAN AERONAUTICAL MAGAZINE

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"PEELING OFF" by John Hammer

FIGHTING ACE FOR '42... Republic Aviation, holding to the single objective of developing the ultimate in high-altitude interceptor aircraft for the Army Air Forces, records its newest and most noteworthy achievement—*the P-47 Thunderbolt,* a super-powered plane for a super-fighting job. Republic Aviation Corp., Farmingdale, N. Y.

REPUBLIC AVIATION

REPUBLIC AVIATION

Back to Starvation?

» THE AIRCRAFT MANUFACTURERS have risen to the call of their country and piled up a miraculous score of deliveries for 1941. Military aircraft production has risen from 799 to 2000 per month and is still on the way up. Total for the year is more than a three-fold increase over that of 1940. We have reached and passed the halfway point in the expansion to a productive capacity of 50,000 planes per year. Our acceleration in production has exceeded that of Germany or England even during their forced-draft expansion before the war. For comparative figures see "Air Defense Progress" by T. P. Wright, AVIATION, Nov., 1941.

Some manufacturers have huge backlogs of orders on the books, and the total backlog of the industry is steadily rising. The danger of profiteering has been adequately controlled by an excess profits tax law, which is so effective that it has been highly successful in discouraging investors from purchasing the securities of aviation manufacturing companies. Anyone who analyzes and is able to understand our excess profits law will think several times before he places his money in aviation enterprises.

Now, on top of all this, come a couple of Congressmen with new proposals to limit profits. One of them is our old friend, Carl Vinson of Georgia, whose legislative creations of the thirties were largely responsible for the starvation period of aircraft procurement and which drove the industry to sell its products and licensing rights to foreign countries, including Germany, in order to remain alive. There were many long years when export business alone unhampered by profit limitation kept plants open and manufacturing talent comparatively intact. The plain truth is that too much of our development expense was paid for by foreign nations. And such an arrangement could not be expected to last indefinitely.

» A SEVEN PERCENT PROFIT LIMIT sounds generous to the unsuspecting citizen who cannot get two percent from his local savings bank. But when you deduct state and local taxes and a few other things, the seven percent actually shrinks up to something less than you could get from the local savings bank.

Now maybe two percent is a fair net return on a large volume of business in some industries. But it certainly is not adequate to provide the vast engineering expenses that must go into the development of tomorrow's airplanes, engines, and accessories, and it is engineering that will be that deciding factor in this and every other war. Have our legislators, in their blindness, forgotten the superb engineering and development organization against which we are competing in the present war effort? Or is it that they don't know the difference between research and development.

» WHILE CONGRESS WAS STARVING OUR MANUFACTURERS and discouraging development in the middle thirties it was also starving our government research organizations. Hardly a year passed but what the N.A.C.A. was forced to fight for its paltry appropriations to maintain a research staff only a fraction of the size of Germany's. Wright Field, too, was eternally plagued by lack of funds. And yet these organizations performed the impossible by making many important contributions to the aeronautical sciences during these lean years.

When war threatened, Congress became a little more generous but even now it is necessary to resort to deficiency appropriations to do the job properly. And our leaders in research are going ahead and doing their job in a highly satisfactory way, under many varieties of handicaps. One of the most serious of these, incidentally, is the necessity under the law of letting construction contracts on the basis of competitive bidding instead of negotiation or cost-plus. And it is very difficult to find contractors willing to go ahead on the old basis when there is plenty of cost-plus business available.

But research, although highly important, is only one part of the job. The other is that part called development, and in this place the practical engineer takes the new discoveries of the research laboratories and moulds them into a better finished product. This is the function of the manufacturer's engineering staff, spurred on by the ever increasing demands of the military and naval procurement organizations. It is from this phase of engineering that the

BEVO HOWARD, whose stunting has thrilled Air Maneuvers crowds, is president of both the Hawthorne School of Aeronautics at Orangeburg, S. C. and the Hawthorne Flying Service at Charleston and Columbia, S. C. All 3 handle Texaco Aviation Products exclusively.

"MEET ME AT MIAMI" might well be the rallying cry among birdmen and other aviation enthusiasts for the 14th Annual All-American Air Maneuvers at Miami, Florida, January 9-11. Everybody goes, everybody thrills.

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FOR THE AVIATION INDUSTRY

RETURN METAL DRUMS PROMPTLY . . . thus helping to make present supply meet industry's needs and releasing metal for National Defense.

continuous flow of new and improved aviation equipment will come. If we cut off experimental development we cannot compete with the aircraft designers of Europe. And it is for this experimental work that our manufacturers must have a reasonable margin of profit.

» THE AIRCRAFT INDUSTRY has struggled to maintain its experimental development through the lean years, and is doing so now when production of existing designs is the primary necessity. We must oppose at all costs, any attempts, under the guise of profit limitation legislation or under any other guise, to stifle the experimental development work which will constitute the deciding factor in winning the war.

» MAINTENANCE AND SERVICING of aircraft, engines and equipment has always been a matter of great importance to the operators of airplanes, both commercial and military. It is still more important in time of war. And when these planes are operating in strange countries, thousands of miles from the factories in which they are built, much of their successful use depends upon the servicing organizations and spare parts supplies at their bases of operation. In the present war it is almost invariably true that the manufacturers who provided the most competent and adequate servicing organizations abroad, were able to gain the most rapid acceptance of their products.

For this reason a substantial part of this Annual Maintenance Number of AVIATION is devoted to servicing problems in time of war. Some of the problems encountered in transplanting our equipment to British bases of operations are discussed by AVIATION's former editor, Vice Chairman Edward Warner of the C.A.B., who performed a valuable service in his recent work in England with W. Averell Harriman. Another article discusses the fundamentals successfully followed in organizing a servicing group in England, by Arthur Fornoff of Bell, who went over with the first consignment of P-39s and did much to help the British understand the ship.

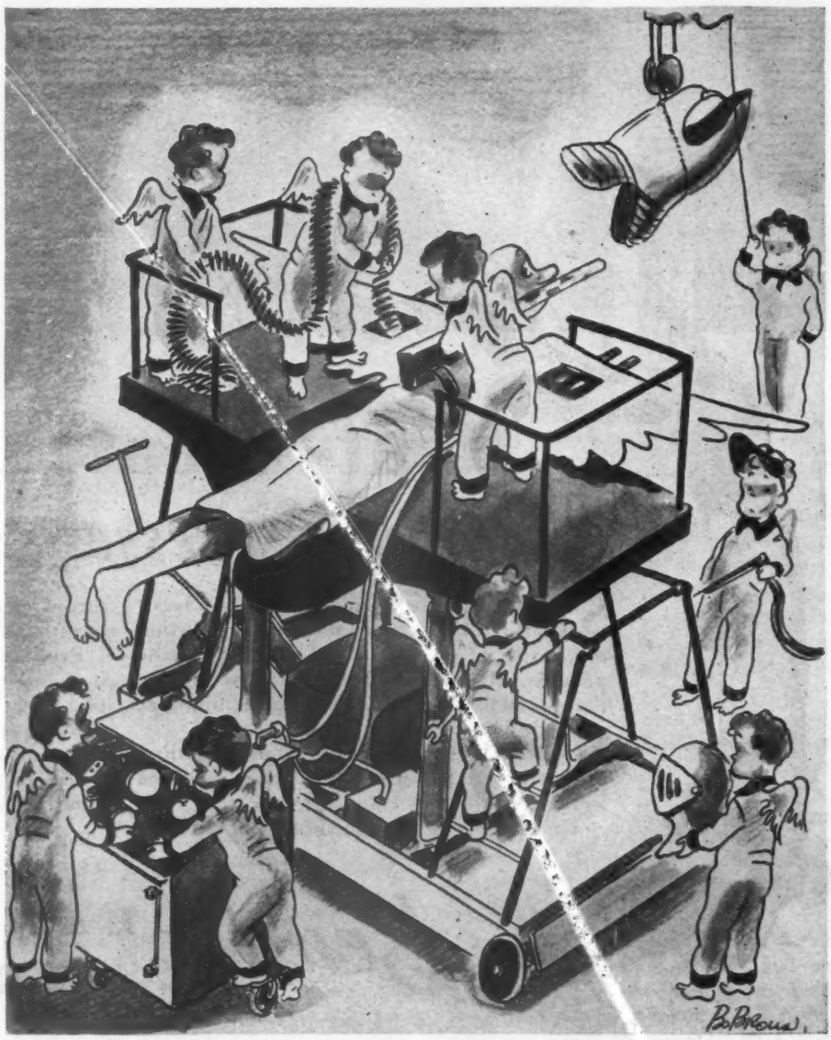
» WE HAVE NOT FORGOTTEN maintenance problems in the United States and we have been able to present a number of articles on the work of the military services at home, the airlines, and the fixed base operators.

Nor have we forgotten the annual airline maintenance awards presented by AVIATION to the airlines performing the most outstanding jobs of the year. For a long time we have felt that we were penalizing the small lines whose limited resources forced them to substitute ingenuity for cash in doing their jobs. Accordingly, we decided to make two awards and set the dividing line between the two airline groups at 100,000,000 revenue passenger-miles of traffic per year. Our heartiest congratulations to the winners,—Pan American in the large airline group, Northwest in the other classification (for details, see p. 50 and 52).

» AMONG THE MOST IMPORTANT FACTORS considered in determining the winners of these awards was good housekeeping and safeguards against fire and shop accidents. Frankly, our surveys showed that there is not enough attention paid to these important elements of successful maintenance operations by a great many of the airlines. This would be bad enough in normal times, but it is much worse now when the experience level of all workers is falling, due to thinning out of personnel for industrial expansion and the obligations of compulsory military service. It behooves all maintenance executives to overhaul their housekeeping methods, fire prevention facilities, and employee safeguards, and to keep accurate records of shop accidents so that they can be studied and means found to reduce their number and degree of seriousness. Tangible rewards will come in the form of lower insurance rates.

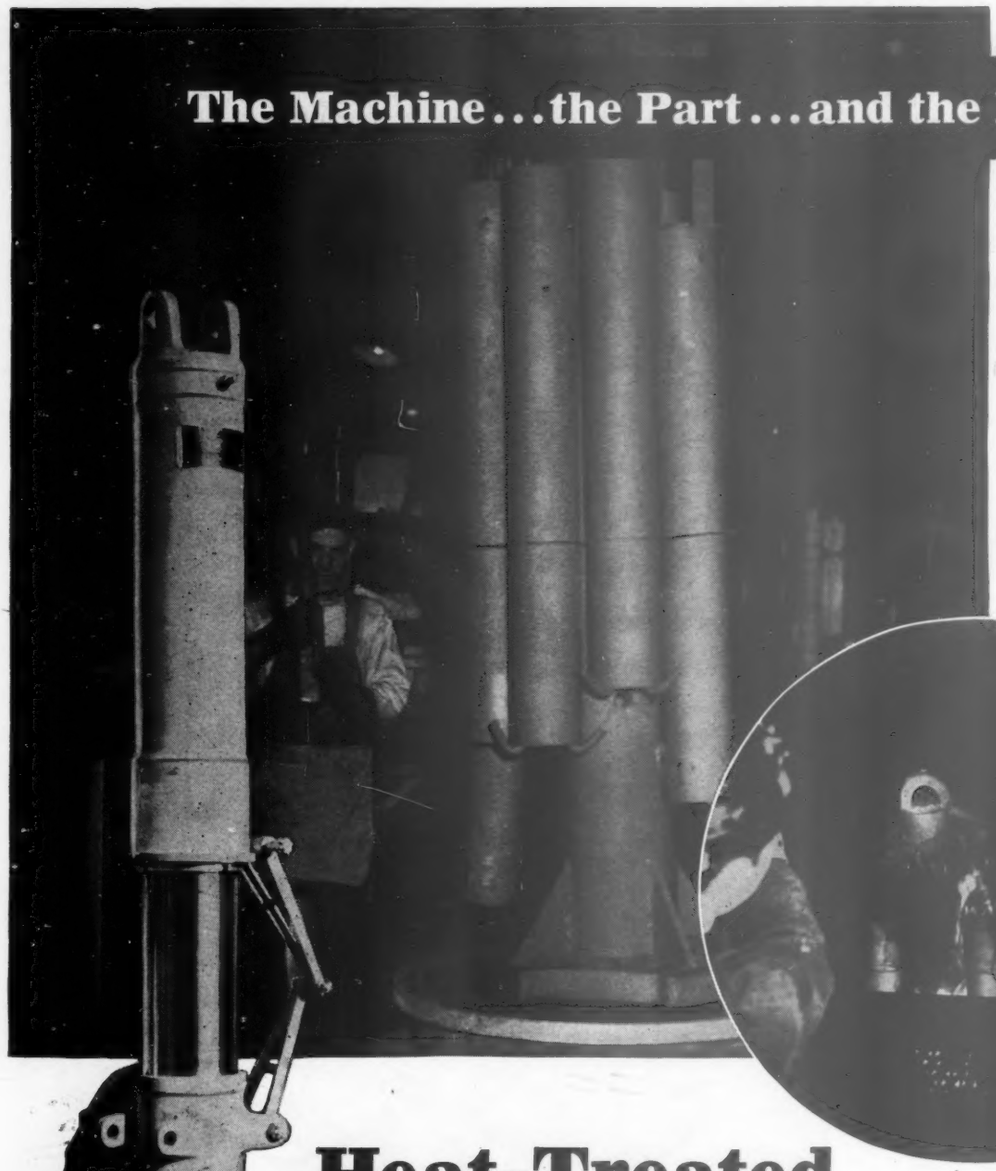
» ANOTHER GRAVE DANGER is that of sabotage and this may take many different forms. Workers must be checked closely, new arrivals investigated carefully, and shops must be guarded more adequately than they were in the wide open days of peace. It is not fantastic to foresee the desire of some foreign agent to liquidate some important airline passenger or to inaugurate a mysterious epidemic of crashes as part of a war of nerves.

SAVE TIME BY AIR



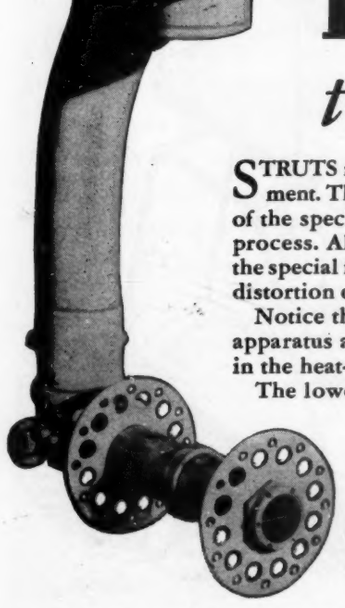
Maguire's maintenance mechanics are fixing him up for combat service abroad.

The Machine...the Part...and the Product



AT LEFT: *Massive fixture for precision heat treatment of shock strut tubes.*

BELOW: *Oil quenching of tubes controlled precisely, avoiding distortion.*



Heat-Treated
to meet stresses safely

STRUTS require extremely precise heat treatment. The illustrations above show a portion of the special apparatus, and two steps in the process. All tubes are heat-treated vertically, the special fixtures being designed to minimize distortion of any sort.

Notice the electrical temperature recording apparatus and the size of the fixture required in the heat-treating bath.

The lower photograph shows the same fixture with the tubes attached, being lowered into the oil quenching bath.

Production precautions such as these, superimposed upon basic design which is the result of a great deal of experience and research, provide accurately predictable performance in Bendix Pneudraulic Shock Struts.

BENDIX PRODUCTS DIVISION
OF BENDIX AVIATION CORPORATION
South Bend, Indiana

Bendix LANDING-GEAR EQUIPMENT

AIRPLANE WHEELS AND BRAKES • PNEUDRAULIC SHOCK STRUTS • TAIL KNUCKLE ASSEMBLIES • PILOT SEATS

» MONTHS AGO we noticed an Air Force regulation which said that parachutes are automatically rejected at the end of seven years. Seemed reasonable enough at the time, but later on we fell to wondering what became of them after that. Goaded on by curiosity we finally called up an officer friend who knows all about such things, and he gave us the works.

At the end of seven years—each 'chute has a sort of log—the silk life saver is taken out of personnel service. If it's still reasonably sound, as it usually is, it is assigned to duty as a cargo 'chute and is dropped with supplies, weapons, tools and so on for the "paratroops."

But if it shows certain defects, it's "surveyed" out of service, and turned over to somebody around the post who wants to make it up into white scarfs

for the flight personnel. That is why you often see pilots, in real life and in the movies, wearing white scarfs.

Not *all* of it goes into scarfs, however. You can have one guess. That's right. It ends up as dainties for the womenfolk attached to the post's pay-roll, or attached to a husband or a swain who is. And there's still more to the story. It's confidential and don't repeat it, but manufacturers often send bolts of silk to the Air Forces for experimental and testing purposes; it's hardly ever all used, that way; and what's left goes where we just told you.

» EL MONTE IS SPANISH, if you couldn't guess, and it means "the willows." It's a place in California, and it's at the end of the Santa Fe Trail, and the new Western plant of Littlefuse, Incorporated, of Chicago, is located there. Littlefuse manufactures small electrical fuses and fuse mountings for instruments, aircraft, radio, etc. The company expanded in California because of the vast increase in airplane production on those sun-kist slopes.

That's your scene, and here's what's going on. The company takes a deep interest in the welfare of its personnel and has gone far beyond the usual along this line. "Music," says a company news release, "selected by the employees is a daily factor of the enjoyment. Instead of a clattering gong at 8 a.m. a time switch throws on an automatic phonograph and a selection of good music goes through the amplifiers, to every part of the factory. Music goes on again at the beginning and end of the lunch hour. At the "fatigue point" in the middle of the afternoon, there is a rest period. Cool fruit drinks and cookies are served in summer" . . . fruit drinks and cookies! Boy, that's taking the hell out of war.

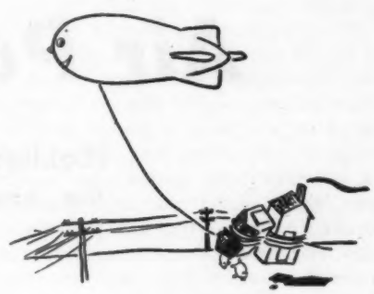
» "I'D LIKE TO GET THIS PASS RENEWED," said a middle-aged civilian, stepping up to the personnel officer at Mather Field and handing him a yellowed card."

Amused, the officer said, "You've been AWOL for twenty-three years."

The pass was dated August 12, 1918 and it read: "This will entitle Ray C. Flory, Squadron "A" Air Service, N.A., to be absent from Mather Field at all times his presence is not required by his duties on the post."

Mr. Flory was a sergeant at Mather in 1918, an aerial gunnery instructor. Upon being discharged, he kept the card as a souvenir. He is now connected with a Sacramento firm that does business with the post. He needed a pass, so he had his little joke on time. Keep it another twenty-three years, Mr. Flory, and maybe you can do it again.

» HERE'S WHAT A RUNAWAY BARRAGE BALLOON DID before it was taken into custody 36 hours later, according to the Associated Press man at Camp Davis, N. C. After breaking away from its crew there, with 2,000 feet of steel cable trailing, it hooked onto and carried away a smoke house full of hams and a pig pen containing a mamma pig and a litter of little ones; shorted a high



tension line and blacked out Camp Davis; shorted power lines 200 miles farther on at Norfolk, Va., stopping a water pumping station which caused a "water hammer" in the pipes which busted a main line; went on and blacked out five more towns in North Carolina; still on, and pulled down a power line, putting seven more towns in the dark for an hour; caught a clothes line near Swansboro and carried off nearly a week's washing.

» "WE CAME IN TO DISCUSS AIR SERVICE TO THE BAHAMAS FOR THE TOURIST SEASON," said the Duke of Windsor, commenting on a visit he paid to the Civil Aeronautics Board in Washington. "There is a great need for air service to the Bahamas to keep the tourist trade going in winter."

For twenty years, man and boy, we've promoted tourist trade ourself, and on the airlines too, just like the ex-king does. Yep, that's democracy, all right. Right now, we'd like to promote a trip for ourself to the warm Bahamas!

International

With power-operated turrets and the famed turbo-supercharger, the Boeing B-17-E is being counted on by England to do much of the high altitude bombing over Germany this winter.

Air Policy and Defense*

Highlights on some of the problems associated with the operation of American aircraft in warfare

By Edward Warner

Vice-Chairman, Civil Aeronautics Board, lately Technical Assistant to W. Averell Harriman on British Mission.

THE alluring possibilities that air power presented to the aggressor had a large share in starting the war; air power now has a large share in determining its outcome. The considerations that determine the effectiveness of air power's use have become vital to every living human being.

Being largely a war of air power, this is largely a war of air material. The material problem is of particular interest to Americans, for it is with material that we are currently taking part in the war in the air. Thousands of American airplanes have been shipped to the British forces. Tens of thousands of others will join them, in a mounting tide until the final victory in which they will have greatly shared has been won.

The performance of American military aircraft, and the service they have given in England and the welcome that they have found there, have been the subjects of a great deal of recent discussion. Questions of aircraft design have acquired a popular interest that they never had before, and they have become the subject of hot popular controversy. Extreme and spectacular statements have received wide circulation. What are the facts?

The basic facts are those that relate to the general quality of the aircraft, and their fitness for specialized military service. Contrary to frequent allegations of national self-exaltation or of national self-depreciation, there is neither general and continuing virtue, nor general and continuing defect, in American aircraft, nor in British, nor in German. Research goes on in all the major nations. Aeronautical engineering follows the same general methods, uses much the same data, and is subject to the same physical laws in all. In all these countries, men of great ability have applied their talents to the design of aircraft and their engines and auxiliaries, and to the improvement of the methods of producing the equipment. There have been periods when the arts of aeronautical engineering have been allowed to lapse into the doldrums in one country or another, with a general inferiority of the national product resulting for the time being; *but there has been no such period in the last five years for any of the countries that I mentioned.* I think it can be honestly claimed that American research and invention have led the way in introducing more important new features into aircraft design in recent years than have those of any other country; and I want to em-

** Excerpts from an address before Foreign Policy Association Forum on October 25, 1941.*

The sudden demand of the American public for information on our aircraft participating in the present war has resulted in the rise of innumerable pseudo experts who have poured out misinformation in alarming volume. Scarcely a day passes in which we do not receive several letters from responsible citizens deeply concerned lest there be some truth in the rantings of these self-styled authorities about the quality of our aeronautical material and the ability of our military leaders. It is therefore with great satisfaction that we are privileged to present the views of one who has made aviation his lifework and has made important contributions to the progress of aviation for more than a quarter of a century.

A former editor of AVIATION, the author needs no introduction to our readers. He has been in the forefront of aeronautical progress in peace and in war and has made many contributions to aeronautical engineering, design, air transport operation, and other branches of aeronautics. During his recent stay in England, where he served as technical assistant to W. Averell Harriman, he had occasion to work at close range on some of the vexing problems associated with the transplanting of American aircraft to foreign fields of operation.

These excerpts, from an address delivered to a recent forum on the general problems of defense, are intended for a non-technical audience and only a few of the many factors in the problem are here discussed. No attempt has been made, in the limited space available, to present a complete treatment of the essentials of the relation of American to European aeronautical engineering. It is our hope, however, that we may be able to offer in future issues, more specialized discussions of the several phases of this subject by the author.

phasize that, because the charge is so often and so inaccurately made that the organization of American aeronautics has been marked by suspicion and hostility towards innovation. I repeat that not even fragmentary support for any such charge can be drawn from the actual record. I would not venture, however, to extend that claim into a claim of any general and inherent superiority for the American product. Still less could any general inferiority be truthfully admitted.

If there is no universal superiority of one nation over another, however, there are many instances of the application of particular efforts, in one nation or another, to the solution of a particular problem on the development of a particular type. A few of the more conspicuous instances of that sort may be mentioned,—instances in which we have followed one line of development, while the British or perhaps all of Europe have followed another, with the result that *for certain special purposes* our aircraft do possess special advantages, while in other respects they work under special handicaps.

The first such instance is that of the heavy bomber. Many countries—Germany and Russia among others in recent years,—have at some time experimented with aircraft of giant size. In most European countries such trials have been a passing fancy, and a dominant consideration in determining policy on the size of the aircraft to be built in quantities has been a desire not to put too many eggs into one basket, but rather to secure a larger number of comparatively small units.

The British had been first to use four-engined airplanes for commercial purposes, and most persistent in developing their air transportation around very large aircraft; but to the four-engined bomber, although they continued development work and now have two excellent types in regular service, they gave a comparatively secondary place. In this country, on the other hand, for at least five years the directive policy of the Air Corps has viewed the large bomber, in the form colloquially known as the "flying fortress," with unvarying favor, and has given it a consistently high priority in procurement planning.

The heavy bomber is now recognized to have a number of special advantages for the present type of operations. Among the most important are its greater relative bomb-carrying capacity over long ranges, the lighter bombers being essentially short-range types; its ability to carry individual bombs of very large size, for attacking concrete buildings and other stoutly resistant structures; and its reduced personnel requirement, as compared with the two or three light bombers that would be required to carry the same total military load as one heavy one. Even the Germans, who have been persistently faithful to the light bomber for overland raiding, have turned to the development of larger types for the long-range operations of the campaign over the Atlantic. The high development of the bomber of 40,000 lb. weight or more in the years since 1935 constitutes one of the greatest of America's special contributions to the preparation of victory.

Another interesting point for illustration, and one that has been the occasion of some intensely acrimonious public discussion by aeronautical writers, concerns the power-plant. Both America and Britain build both air-cooled and liquid-cooled engines; but the concentration of effort upon the air-cooled types has been more intense in America than in Europe. There has been more hope in America that air-cooled engines could be made to serve all purposes, and the American air-cooled power-plants have made a world-wide reputation; but the British have built many more liquid-cooled engines than we have, and they have advanced more rapidly in increasing the power of the individual engine toward the present maximum of some 2,000 hp. Since most high-performance fighting aircraft are designed around liquid-cooled engines, our less intensive activity on that type of engine has imposed limitations on fighter development. Liquid-cooled power-plants are now in production here, and the development of new models of higher power is being pressed forward with all possible vigor; but we lack the British advantage of continuous development and large-scale application over the past decade.

The last point that I select for mention is that of the design of aircraft engines for maximum performance at very high altitudes. There are two general ways of making an aircraft engine maintain its full power in the region of rarefied atmosphere. Dependence may be placed entirely upon a supercharger built into the engine itself; or there may be a supplementary provision of a supercharger attached to the engine as an accessory, and not mechanically connected to it, but driven by the exhaust gas. European development has concentrated on the first method; America has given much attention to the second. The auxiliary type of supercharger has been the subject of study and occasional experiment in England, in Germany, and in France, but only in America has

(*Turn to page 186*)

Edward Warner

Quick Turn-Around

Pan American Airways has maintenance bases at Miami, Rio, Brownsville, San Francisco, Seattle, and New York—plus new shops being set up in Africa. Top-rank maintenance can be found at any of these places. Aviation's Maintenance Award is presented to all of the 2,500 mechanics and supervisors along these far-flung routes. Each shop in its turn has had to do its own pioneering. The following account of maintenance methods being used on the North Atlantic service is typical of the originality and skill being used on all Pan American routes. It concludes a series of three articles on trans-oceanic operations.

By Edward W. McVitty

Division Engineer, Atlantic Division Pan American Airways System

WHEN transoceanic flying boats of the Boeing 314 type, were first placed in operation four years ago, an average flying time of 4½ to 5 hours a day on an airplane was considered good. On the transatlantic service we are now approaching the neighborhood of nine hours daily on this type of airplane.

With the addition of the recently named Capetown Clipper to the Atlantic fleet we now have four airplanes in this service, the same number with which we started operation in 1939. In that year we were averaging 18 flying hours per day on the fleet, about half what we are doing now. This means that four airplanes in 1941 are performing work which is the equivalent of that which eight similar airplanes could perform in 1939.

Explaining the situation in a different way, and viewing it from the economic standpoint we had a fleet of airplanes in 1939 which cost $3,000,000. The work being performed right now is similar to that of a $6,000,000 fleet of aircraft. When such a situation is viewed with this angle in mind it can be easily understood that substantial investment can be made in such necessities as shop equipment, inspection facilities, etc., to obtain more intense performance and still leave the operator, financially speaking, well ahead of where he started. To obtain the above, Pan American Airways had to reduce the maintenance time on these 84,000 pound Clippers from six days to two. In one-third the time that it formerly took, the company is performing as many items of maintenance on the Clipper between round trips across the 3,890 mile route between New York and Lisbon as when service first began. The number of items in such an operation may amount to as many as 1500.

In common with all airlines, Pan American Airways has had a drastic need to show such improvement. The war and the defense program, which have tremendously increased the demand for all types of air transport service, have simultaneously removed the possibility of meeting that demand through an increase of flying equipment. The only solution to the situation which has arisen is to use the aircraft on hand for more flying in any given period. That, in turn, means doing more maintenance work in any such given period upon aircraft available for maintenance work during such reduced periods.

The only difference between the problems to be met by the domestic airlines and the burden placed upon the Pan American Airways maintenance base at LaGuardia Field by the outbreak of the European war, is that the impact of increased traffic demands fell upon the transatlantic airline at least a year earlier than it began to have a controlling effect upon domestic operation. Perhaps, therefore, it would be worth while to go into the means by which Pan American Airways has cut its maintenance procedure time so greatly.

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This year AVIATION is presenting two Maintenance Awards —one to an airline operating over 100,000,000 revenue passenger miles per year and one to an airline operating less than that amount. Awards were presented at the maintenance meeting of the Air Transport Association in Cleveland on November 11.

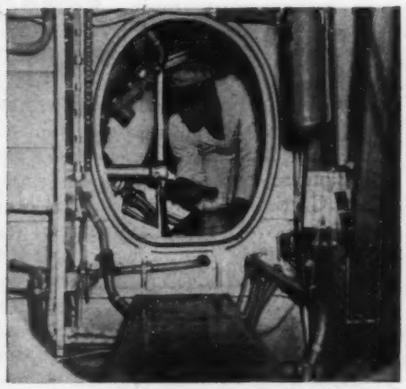
Winner of the Award for airlines operating over 100,000,000 revenue passenger miles was Pan American Airways. Since its inception, Pan American Airways has been a pioneer, not only of new routes but of new maintenance methods as well. This airline has inaugurated more new types of airplanes than any other line. It is the chief operator in the entire world of large commercial flying boats. In the maintenance of Sikorskys, Martins and Boeings its engineers and mechanics have had to chart new courses, developing their methods by the sweat of their brows. A long series of landplanes has also passed through Pan American shops—Fords, Fokkers, Douglases, Boeing Stratoclippers, Lockheeds —to name only a few.

Pan American is more than an airline—it is a vast system of airlines. Its 88,500 miles of routes extend from Lisbon to China, from Alaska to Rio. Its maintenance shops are often far from a source of supply—its mechanics thousands of miles from their homes. Wherever the ships of Pan American fly, good maintenance methods accompany them.

Work goes on 24 hours a day. The big principal 3-deck work stands are supplemented by inspection ladders, platforms for servicing ailerons and tail surfaces. A whole fleet of trucks, tractors and dollies is used.

The metal-working department includes complete equipment for shaping, riveting and welding.

Refinements in beaching gears and handling technique have cut beaching time from five hours to one.



Inspection starts the minute passengers leave the plane. Here an inspector uses the walkway through the wing.

The big 3-decker work platforms have complete shop facilities for engine and propeller work, cabinets for cleaning materials, foremen's tables, inspectors' tables, batteries of flood lights, chutes and containers for oil soaked rags, elaborate plumbing. Bulletin boards carry an up-to-the-minute record of all work orders completed.

Northwest Airlines Wins Aviation's Maintenance Award

for line flying less than 100,000,000 revenue passenger miles per year.

NORTHWEST AIRLINES has been doing a fine maintenance job since the line started 15 years ago, when equipment consisted of OX-5 engines and Curtiss Orioles and Thomas Morse planes. Over the intervening years Northwest has steadily increased the size of its airplanes and extended its routes. Now it flies from Chicago out over the northern Rockies to Seattle and Portland. If Croil Hunter's hopes materialize, his line will have routes from New York to Alaska via Minnesota, and the Dakotas.

From president down to the men who sweep the hangars, Northwest has always been a maintenance man's airline. During lean years in the past, when dollars had to go a long way, maintenance superintendents, shop foremen and mechanics designed and built new test equipment and many new facilities for handling and servicing airplanes. Today, wherever one turns in the overhaul base, there are evidences of the inventiveness and ingenuity of maintenance men.

To maintain its fleet of Douglas and Lockheed planes, Northwest employs some 250 supervisors and mechanics. They are distributed over eight stations: Chicago, Minneapolis, St. Paul, Fargo, Billings, Spokane, Seattle and Portland.

Maintenance work is done so carefully that mechanical failures are few and far between. Hours between overhaul of equipment, as approved by C.A.A., are among the best in the country. Maintenance costs per mile flown are low, but not so low as to indicate a neglect of important items. Mechanics are well trained and turnover is low. Morale of the maintenance staff is excellent. Shops and hangars along the entire route are clean, orderly and reflect a pride in their work on the part of the men. Due to clean shops, good equipment and thorough training, few accidents occur to shop personnel.

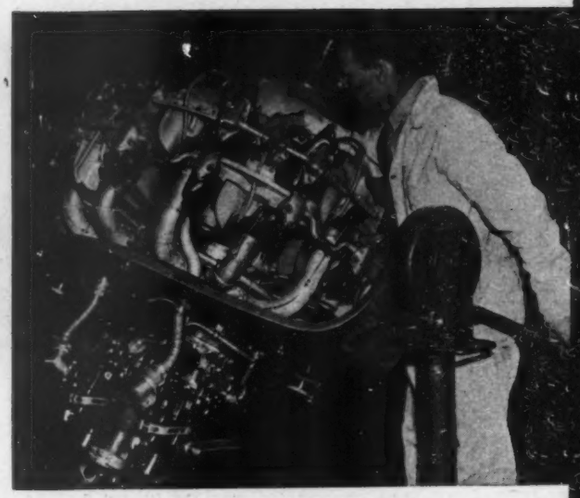
Northwest's men are thinking continuously about new ways to improve servicing methods. One example is the pressurized ignition harness devised by maintenance engineer Carl Swanson. The line had had some engine failures due to ignition trouble. A strenuous

Typical of Northwest's department heads is Chet Brown, head of propeller shop. He devised a clip to hold blades to hub enabling one man to do work of three; also an improved propeller balancing stand, a new hoist and a blade locking mechanism. Left: Joe Shuster, NWA prop. man.

Northwest has a skilled group of engine men. Here, left to right, are Martin Leadon who heads up engine installation and accessory overhaul, Ed. Mathews and Bill Hohaq. A fast method of engine changes has been worked out. Changes are often made at Minneapolis. All engines are made by Pratt & Whitney.

Northwest's president is Croll Hunter, a staunch believer in good maintenance.

George Gardner, V.P. of Operations, has contributed much to fine maintenance record.



Al Volk demonstrates an engine stand which can be shifted in position by turning the crank at right.

Ralph Geror is Maintenance Superintendent. On him rests the final responsibility for keeping airplanes in serviceable condition along Northwest's extensive routes. He is one of youngest maintenance chiefs.

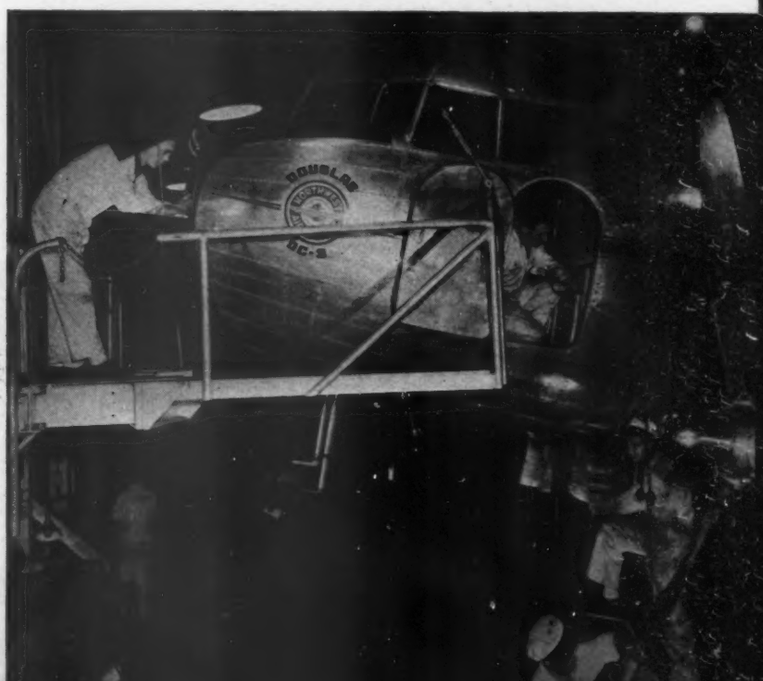
Henry Aune, former maintenance supt., is expecting Navy duty; meanwhile is superintendent of engine dept. For many years he has been a solid builder of dependable maintenance practices.

attack was made to solve the problem and the pressurized ignition harness was the result. Chet Brown of the propeller shop has devised new equipment for shop use as well as suggested solutions to design problems that have been used by Hamilton Standard. New tools, new test methods and maintenance procedures are found in each of the service shops.

NWA's research engineer, Carl Swanson, developed this pressurized ignition harness which has done much to eliminate ignition failures. Bert Van Kampen is shown shooting 10,000 volts through tubes during test.

Maintenance shops are busy day and night to keep planes flying.

Much special test equipment has been designed or modified. Magneto testing is done in this sound-proofed case, shown with front removed. A glass window in the front panel enables Vernon Bemis, shown here, who is in charge of magneto overhaul, to observe the five hour test given after overhaul.



Air Corps Learned Plenty ON MANEUVERS But Did the Ground Troops?

By Garrett Underhill

The author has been a close observer of military affairs for a number of years. Since the present war began he has been in a position to see numerous unpublished reports on both air war and ground war on each of the battle fronts. During the recent maneuvers he traveled hundreds of miles, seeing at first hand the activities about which he has written in this article.

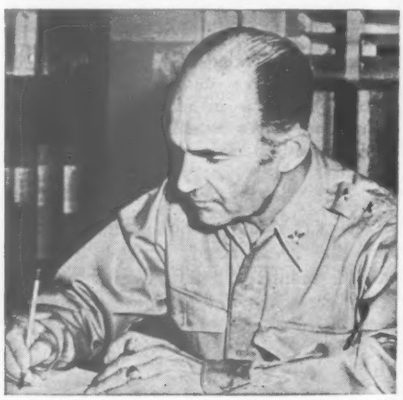
THE air-ground operation in the GHQ phase of this year's Louisiana maneuvers involved the greatest military force ever assembled by this country for peacetime exercises. Though the shortage of material remained acute, for the first time in 21 years sufficient planes and equipped ground units were on hand to lend an air of verisimilitude to Army large-scale mock combat.

In the main and longest inter-army battle, 213,000 ground troops of Lt. Gen. Walter Kreuger's Third (Blue) Army opposed 123,000 troops comprising the Second or Red Army under Lt. Gen. Ben Lear. Assisting the Blues against the superior armored and more mobile Red forces were the 200 pursuit and 106 bombardment aircraft of the Third Air Task Force under Major General Herbert Dargue. The Red Second Air Task Force wielded by Major Gen. Millard Harmon comprised 148 bombers and 156 pursuits. The total of combat ships was thus 306 Blue to 304 Red—an equalization made possible by the allocation of no less than 100 bombers and 60 fighters from the Navy and Marine Corps. With observation planes under ground army control added in, the grand total of all the tactical planes was 438 for the Blues, and 388 for the reds.

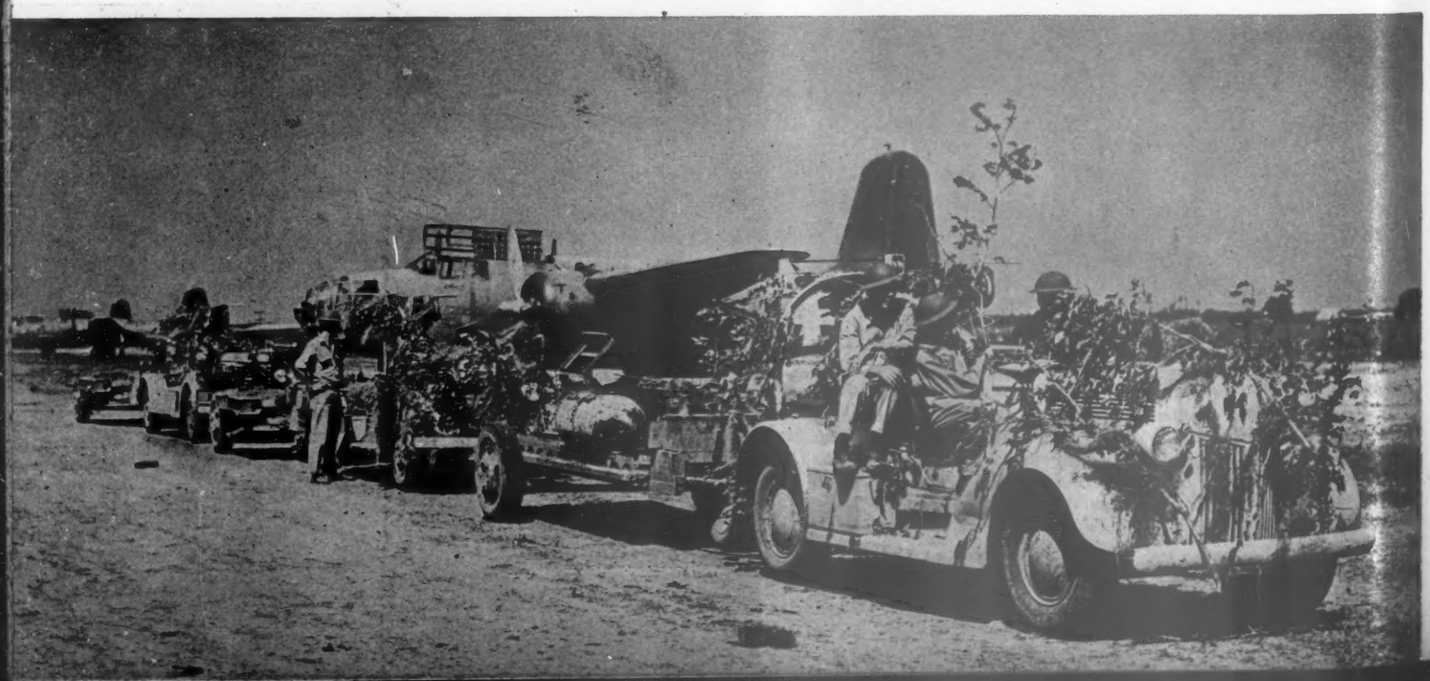
In spite of the stunning impact of Lend-Lease policy upon Air Corps procurement and training programs, the Air Task Forces and observation squadrons acquitted themselves brilliantly. They indicated that the Air Corps, in comparison with ground forces, has a superior ability to withstand over-rapid expansion, and is better prepared for the coming war.

After months of small unit training, the conduct of the average ground soldier and junior officer was a severe disappointment. Deficient in fundamentals of scouting and patrolling that every hunter ought to know, officers and men

Major General Herbert Dargue who commanded the Blue Air Force, Third Army.



Major General Millard Harmon, leader of the Red Air Force of the Second Army.



Partially camouflaged tractor and trailers roll 1,000 lb. bombs past a line-up of Blue A-20-A's. Umpire rules compelled all Air Corps units to simulate loading of bombs and machine-gun ammunition before flying combat missions.

A Red Curtiss P-40 E under protective camouflage screening built at Esler Field by engineers assigned to work with the Air Corps. Most pilots preferred to leave ships unprotected.

Anti-aircraft units assigned to this Blue field made a weak attempt to camouflage pup tents and guns. It is apparent they were little concerned about keeping hidden from an air attack.

These men of the Red 1st Armored Division are being strafed by a Blue A-20-A. Many gunners did not bother to practice firing on moving enemy planes. Much valuable experience was lost.

Morale of air mechanics was high. These men of 1st Observation Squadron, tired with the day's work, labored all one night to give this Stinson 0-49 a needed 100-hour check so it could fly next day.

Douglas attack bombers releasing 100 lb. bombs in trail as a demonstration of area bombing for Army officers assembled at Barksdale Field

Lockheed P-38's performed brilliantly. These fast fighters were definitely the show planes of the maneuvers.

A Stinson observation plane of the Red Army working cooperatively with an armored half-track. Observation squadrons worked steadily and turned in a fine performance. The 0-49 proved itself to be an excellent airplane and won praise for its maneuverability.

would walk and even ride right into enemy outposts, or else become hopelessly intermixed with other elements of their own forces. At one point a small Blue cavalry detachment captured or annihilated Reds several times their strength, took cargo trucks, a division artillery commander and party, defeated a platoon of armored scout cars,—all because the Reds would insist on driving or marching full tilt along improved roads without the slightest concern for possible changes in the front line. At another place, a Red battalion three times tried to deliver an ordered assault, and each time the attack fizzled out because its line of advance was already clogged with support elements of other Red units which had got there first.

All ground operations were conducted in an atmosphere of mystery, confusion and indecent haste. So abnormally rapid for untrained troops was the tempo of most movements that avoidable errors were committed and bad habits compounded. Unusual was the unit that took the time and trouble to select suitable emplacements for its guns, and to protect and camouflage them even in an elementary way. So preoccupied were troops in rushing about that the simplest rules of cover and concealment went unheeded. In one instance, Blue infantry walked right across an open field in the face of the annhilating fire of four heavy Red machine guns, and by out-arguing weak-willed umpires actually carried the impregnable Red position. Unfortunately the speed and carelessness of these maneuvers had significance outside of an indication of the state of small unit training. These faults meant that higher commanders could not obtain a true conception of the facility and success with which wartime operations could be carried out.

In contrast, the air forces were a pleasant surprise. They, too, worked at a high tempo. In fact, many more missions were flown than had been anticipated. Nevertheless, each mission was normally well-flown and thoroughly umpired. This had to be, since in the air there was less opportunity for surreptitiously cutting corners and getting away with sloppy performance.

It is true that with superior radio communications, air operations were more under central, and therefore, more able control than were the diversified and innumerable actions on the ground. With civilian air raid warning nets functioning fairly well, and with radio locater units in use, interceptions of raiding pursuit and bombardment were carried out with infinitely greater certainty and knowledge than were the assaults or counter-attacks of the land armies.

However, the pilots and squadron commanders proved themselves fully competent in handling situations once higher echelons had passed them on. On the first day of the army phase, a

Two photos above show right and wrong way for motor columns to operate. Top picture shows widely spaced units of 33d Division. Machine guns are ready to fire. Lower picture shows Red armored forces bunched closely together in spite of Blue air domination. After their first curiosity was satisfied, majority of ground troops paid little attention to air strafing.

Left: the 2nd Army field at Lake Charles, La. In foreground, masked with the white cross of the Blue air force, is a Douglas transport. Light grey planes in centre are Navy Grummans. At lower right are mobile repair shops. This concentration of valuable equipment shows a dangerous disregard for enemy bombers.

Red pursuit formation was returning to Barksdale Field. As it began to form a landing circle under the low overcast, Blue P-43s swept out of the rain clouds and pounced on them. It turned out that the Blue intercepter officer had sent out his squadron at just the right moment—for all Red pursuit at Barksdale were servicing—and that his squadron commander had chosen the proper time and place for the attack. Before fresh Red interceptors could take the air, the Red P-40s which had not already landed were out. No sooner was that action complete than the Blue squadron picked out and shot up nearby artillery ammunition trucks of the First Armored Division. In war this surprise attack on the most vulnerable part of the armored march column would have raised havoc with the passage of the tank division through the choke points near the Shreveport bridge.

If anything, the air forces may thus be said to have normally done the right thing at the right time. When accompanying Red armored divisions in the main and longest battle of the maneuver, one could count on a devastating attack from Gen. Dargue's bombers the instant any concentration was made. Red engineers maintaining the vital 1000-foot pontoon bridge across the Red River at Campi were kept very busy replacing bridge sections which were umpired out, for no sooner would repairs be complete after one bombing

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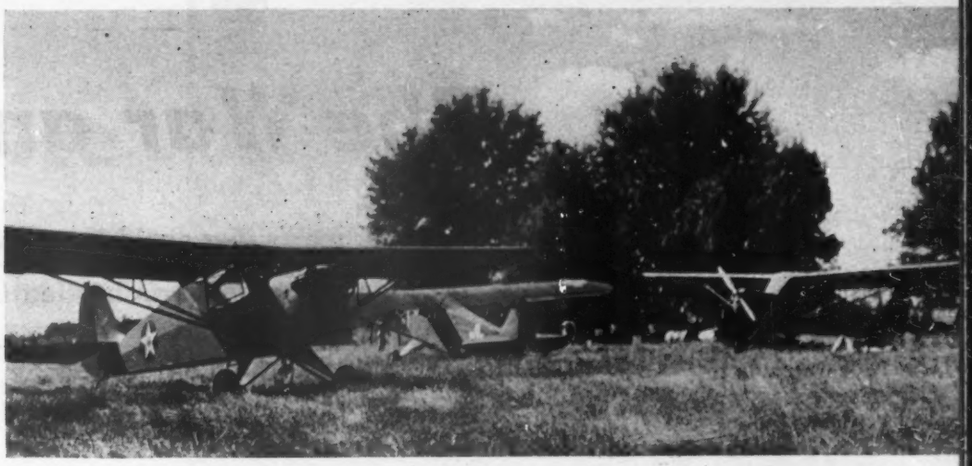
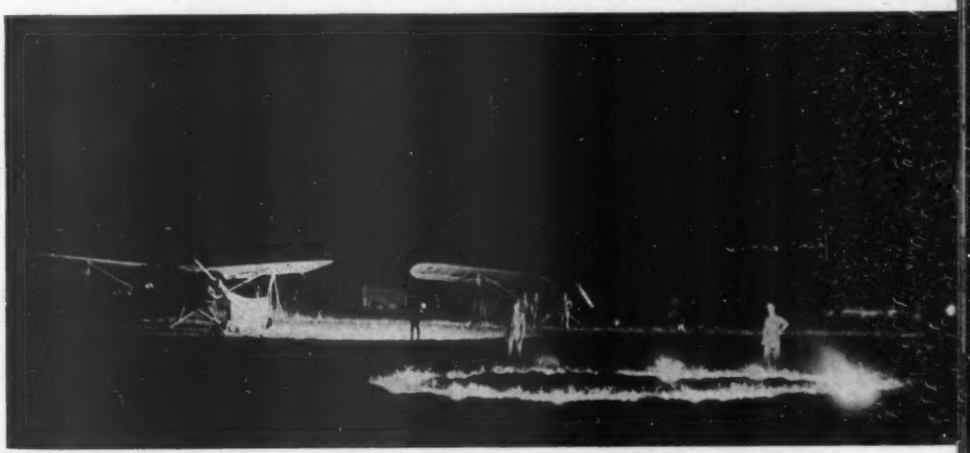
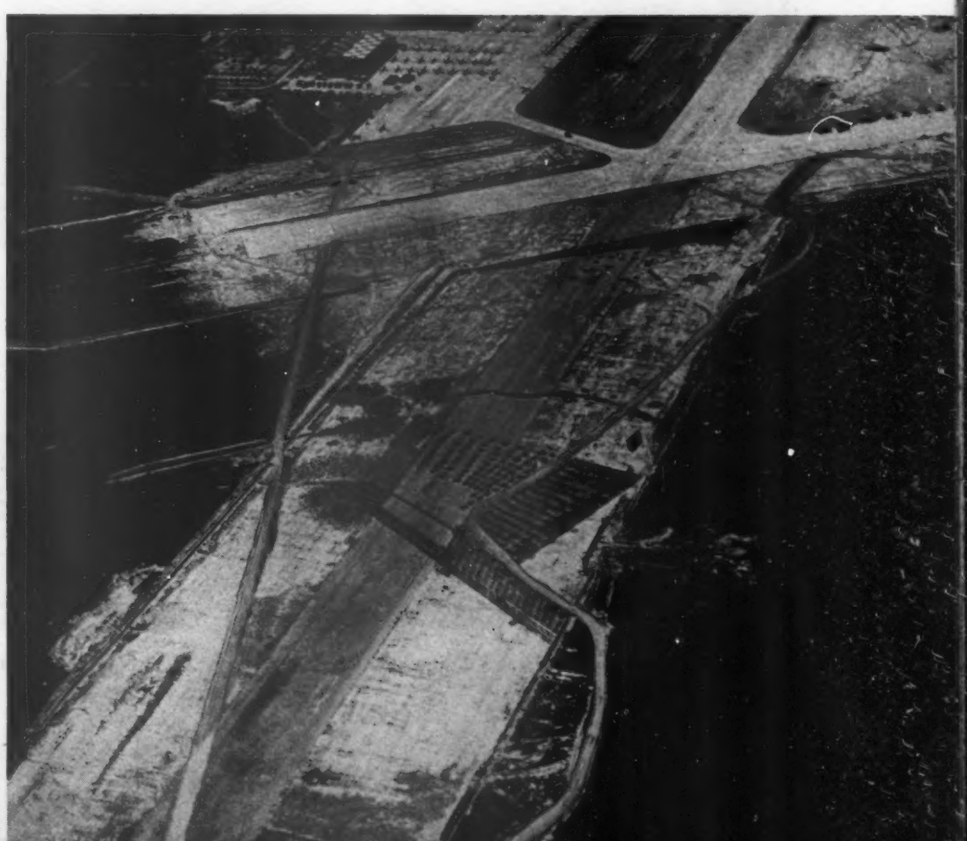


Many hot-shot pursuit pilots were afraid to fly these grasshopper planes. Pipers, Aeroncas and Taylorcrafts were used to excellent advantage by both sides. They were able to get along without airports, landing on roads.



Above: 1st Observation Squadron awaiting the dropping of a message by an 0-47 A. The fire ring of gasoline is lit in a pasture to locate spot for pilot. Planes shown in background are Stinson observation ships.

Small photo above shows detail of large airfield at right. Rows of long grass were piled to simulate a farm. Rows were continued over runway by blackening it with waterpaint. The runway itself was darkened and texture roughened by applying mixture of waterpaint, cottonseed hulls and sawdust. Effect from 500 ft. is shown at right. From 10,000 ft. the eye could not detect darkened runway below intersection with horizontal runway. Fake farm, ditch crossing runway and orchard of round blobs would make deception complete. This field is at Camp Beauregard.



The War and Aircraft

The head of Lockheed's world-wide service organization reveals some of the lessons his firm has learned from the war.

By Reagan C. Stunkel, *Customer Service Manager, Lockheed Aircraft Corporation*

"KEEP 'Em Flying!"

On the billboards and the radio, emblazoned across the country in newspapers and magazines and on the lips of Americans, young and old, the slogan "Keep 'Em Flying" seems to have rung the bell in the minds of Mr. and Mrs. John Public. Little do Mr. and Mrs. Public realize that the tremendous task of fulfilling their maxim is one delegated not to our tremendous production facilities but rather to the maintenance organizations of our military air services. And a prodigious task it is!

Strangely enough, there is little precedent around which such large scale maintenance may be planned. Certainly there is little to be derived from the last war. The airline systems, with their smoothly functioning scheduled operations are not sufficiently mobile to permit the extraction of many lessons. Our military systems, on a peace time basis up to the beginning of hostilities abroad, must undergo an abrupt expansion completely beyond the realms of comparison with any similiar program by virtue of the size of the undertaking.

Recognizing the importance and enormity of the job to be done, on April 29, 1941 the Air Corps created the new Maintenance Command at Wright Field. A completely new branch of the Air Corps organization, the Maintenance Command has already made deep inroads into the maze of problems presented by the maintenance of our new Air Force.

It will be of interest to review some of these problems. The modern fighting airplane is a complex bit of machinery to maintain in operating condition. With the advent of high output, turbo-supercharged engines, complicated hydraulic systems, automatic power plant controls and innumerable other advancements, all applied in a different manner to different types of aircraft, maintenance problems mount to formidable heights in direct proportion to the number of aircraft being operated. Add to this the inevitability of the most difficult operating conditions imaginable, for the days are gone when work can be accomplished in the warm recesses of a well-lighted hangar, and some idea of the heartbreaking task may be had.

The British have found that under actual conditions of war, it is impractical to keep more than a very few aircraft in a hangar at the same time. They must be spread around a field, under trees or camouflaged to prevent loss due to bombing. The maintenance must go on, however, in spite of the ravages of the elements.

Aircraft returning from combat flights may require new wings, engines, or other major components. These changes must be made in the open under the most trying conditions. Maintenance equipment, then, must be designed for just such conditions. Aircraft jacks, used to lift the planes to check landing gear operation, must not sink into soft ground when the weight of the aircraft is applied. When the airplane is jacked up, a gasoline driven hydraulic test rig must be used, since no power is available for electric driven equipment. If an engine is to be changed, a portable crane must be available to swing the old engine off and the new one on.

Reagan C. Stunkel

Aircraft damaged so severely that repair is impractical in the field must be returned to the major repair depot. We have seen aircraft return with entire sections of the fuselage, tail group or wing shot away. One aircraft actually completed its mission with one entire bay of the fuselage shot away, leaving the interior open to the airstream. At times these damages are not sufficiently great to justify returning the plane to a depot. It is then a squadron maintenance problem. A portable workshop with drills, riveting equipment, and a source of power supply for operating the equipment must be used for this type work. Generally speaking, a repair job requiring less than 48 hours is accomplished in the field.

The question of the proper equipment

Moving damaged bombers from a distant point to a major repair depot is a job requiring great dexterity as well as ingenuity. These are Lockheed Hudsons.

Maintenance

for field repairs is a vital one. A great deal of foresight and planning now in the selection and design of maintenance equipment will make the maintenance man's job an easier one later. Above all, the equipment must be mobile as a unit or "en masse". Operations in Europe have demonstrated that armies must move rapidly and can place little reliance on fixed base maintenance activities. The equipment must be carefully selected to permit the accomplishment of any field service job which may be presented.

Aircraft forced down away from the operating base are often damaged beyond the resources of the field repair station. In England these aircraft are quickly surveyed, and if repairable are given the necessary temporary repairs to permit the aircraft to be ferried to the Depot. Aircraft not so repairable are likely to be scrapped. Surface transportation of aircraft in England is difficult due to the narrow confines of the highways.

In most localities in this country it is possible to convey moderate sized aircraft by highway to a depot. Activities outside the boundaries of the United States are likely to be more restricted, however, and necessitate, in some cases, the abandoning of damaged aircraft because of the exorbitant cost of bringing them to a depot. In any event, special equipment and trained personnel are required to handle the survey repair, or transportation of equipment to a depot. Under wartime conditions, this job is a particularly important one since scarcely a single large-scale activity will pass without the necessity of retrieving damaged aircraft.

In general, it is much more practical to effect temporary field repairs to permit damaged aircraft to be flown to a major repair depot. These temporary repairs must be accomplished by a mobile field unit, either flown or transported by truck to the scene of the repair, and by personnel well versed in the emergency repair of any type of aircraft.

Our own Air Corps has a number of well equipped and expertly staffed Air Repair depots. These are being augmented by additional depots located at

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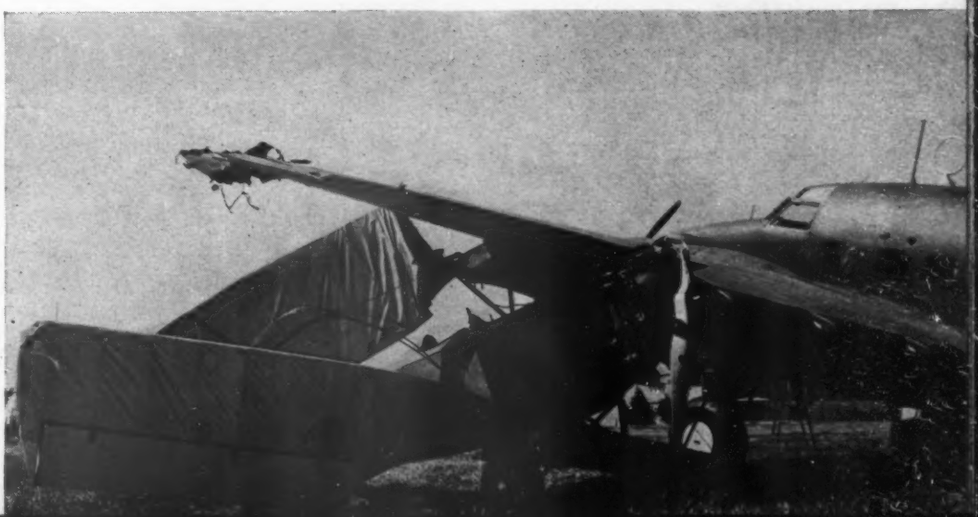
Considered as minor damage, this shell-torn wing is repairable in the field. Repairs of this type must be handled efficiently and rapidly.

This damage is also repairable by field maintenance men.



The Hudson at the right can be put in operating condition in the field, but the trainer is damaged so badly that it must go back to a depot before it can fly again.

Keep 'Em Flying—Abroad

Acceptance of American airplanes abroad depends not only on the quality and performance of individual types. Another important factor, too frequently neglected in the past, is the adequate supervision of maintenance service.

By Arthur L. Fornoff, *Service Manager, Bell Aircraft Co.*

WHEN in the early fall of this year Airacobras began reaching their fighting stations in Britain our service men had long been planning, planning against every conceivable eventuality which might prevent these planes from rendering the maximum service for which they were so painstakingly designed and built.

On the basis of subsequent experience, the organization of service and maintenance abroad has resolved itself into eight major phases;

1. Preliminary preparations here.
2. Establishment of erection base abroad.
3. Flight testing after assembly.
4. Inspection to determine operational fitness as of that date.
5. Preparations for modifications to make plane operational.
6. Day-to-day task of keeping planes in service operational.
7. Provision of trained personnel for instruction in actual overhaul and repair.
8. Coordination with "sister" firms abroad.

Art Fornoff went to England in June to establish assembly and servicing facilities for Bell Aircraft, and returned the middle of August. Traveling by transatlantic Clipper, the crossings were accomplished without incident. He is leaving again, early in November, to continue his good work in Britain.

Eloquent testimony to the value of Fornoff's service abroad is contained in a recent letter from Edward Warner, Vice Chairman of the Civil Aeronautics Board, who himself spent some months in England early this year. He writes: "The role of the American industry's service representatives in England and in other combat areas is of enormous importance in getting the American equipment into effective service, and so to the general success of the war effort. Even the best of aircraft and the best of operating organizations will benefit by being properly introduced to one another; and it is immensely helpful to have new types accompanied or preceded to the war area by properly qualified factory representatives, acquainted not only with the details of design, construction and maintenance requirements, but with the tests undergone and the operating experience acquired in the United States. It is not easy to spare men of the right stamp from the factories, hard-pressed as they are by the problems of production; but no one could have spent any time in England in recent months without feeling the importance of assigning such men as Mr. Fornoff (of whose services I have heard very flattering report from England) to stations in Britain. There have been a number of such men, representing a number of companies; but during my own time in England the supply seemed always to fall well short of the need."

The Expeditionary Force

Although on an infinitely smaller scale, we nevertheless planned our British expedition with a thoroughness that would have done credit to Hitler's own Blitzkrieg commanders. Drilled into each man was the resolution that nothing short of total demolition should stand between these fighters and the thin air high above Britain. Moreover, they were instructed to assemble and relay to the United States all possible information to assist us in providing better and better airplanes as time went on. The various phases of the program are discussed in the order listed.

One. To date, seven of our ablest engineer-mechanics have been selected to assist me in supervising service and instructing British mechanics in maintenance of our airplanes. At the outset, a number of complete servicing kits were assembled. They were sent by different routes at different times to insure the safe arrival of at least one in spite of possible mishaps, and a master reference set remained in the United States.

Each kit contained a complete set of tools necessary to perform any repairs, complete sets of blueprints and drawings and all operating and service manuals. Each man was advised that he need not be financially responsible for any tools left in England, for it was felt that to leave these tools wherever a need existed was far more valuable to us than the cost of replacement. In the case of large or special tools which were to be supplied under contract or by the customer, complete blueprints were included so they might be duplicated in an emergency.

Two. As soon as the erection base was selected, our men went to work setting up assembly lines patterned on those of the home plants. We arranged for the procurement and training of

A squadron of Bell Airacobras in England.

British Press Service

local labor. We endeavored to train these workers to perform a few operations efficiently at a single station in order to train our crews in the shortest possible time. Dollies, workstands, hoists, all had to be in readiness.

Three. As the aircraft were assembled, utmost care had to be exercised to see that each airplane was in perfect shape to deliver a safe and satisfactory performance. Particularly in view of the many handicaping circumstances was it necessary to conduct the most rigid inspection of each plane and its equipment before okaying it for flight.

Four. Following the completion of successful flight testing, operational groups inspect the plane to determine what modifications need to be made in design or equipment to bring the original model up to date in accordance with operational requirements as of that time. Under wartime conditions improvements are developed and applied with surprising rapidity and certain operational requirements must be met which are rarely foreseen prior to actual combat operations. With respect to the Airacobras, only minor changes were found to be necessary.

For example, the antenna location might be satisfactory for normal operations, but might constitute a real hazard to a weary fighter pilot jumping out of his cockpit in absolute darkness. It must be moved to avoid any possibility of injury to the pilot. Ammunition boxes, oil tanks, refueling points, prestone tank, all must be easy of access and simple to find and service in darkness and under all weather conditions. Guns must be so installed that they can be pulled out and replaced in a matter of minutes. All such modifications must be made before the plane can be accepted for combat duties.

Five. Not only must the modifications be made on the aircraft already completed and those under assembly, but preparations must be made to see that these changes are accomplished with a minimum loss of time on all planes in process of manufacture and to come.

Six. Once the planes are made operational and placed in active service, there begins the long steady grind of keeping each one serviceable, day in and day out, under all weather conditions, no matter where it might be. This cannot always be accomplished by merely following the letter of a legal contract. It requires compliance with the spirit of a contract of good intent which transcends ordinary concepts of servicing obligations.

In this connection, I have never forgotten the attitude of one of my earliest employers. He was in the automobile business. "Service," he told me, "is nothing more than being pleasant to the customer to keep him satisfied. If a recent buyer comes back and wants you to look over his car, just stand on the running board and look over the top; technically, you will have fulfilled your obligation."

My deep personal conviction ever since has been that he confused "looking over" with "overlooking." He overlooked the important thing. You can't keep a customer sold throughout the years by such tactics. So, our service men are not likely to quibble over the line where their responsibility ends and some one else's begins, nor do they wait to "let George do it" or haggle over items of expense. Nothing short of an act of God or man-made catastrophe of major proportions will deter them from procuring spares or tools, effectuating repairs or whatever else is necessary to keep their ships flying. To this end, they are given all cooperation and encouragement possible by the remainder of our organization.

Seven. Since, obviously, a Bell Aircraft service man could not always be available as the numbers of Airacobras in service swelled rapidly, we exercised the utmost care in the selection of men to serve as instructors to British assembly workers and service teams. Four specialists were chosen on the basis of their experience and the ability to impart their knowledge to others. They comprised a structures and stress engineer, a man who knew all the answers on assembly and production, an instructor on repair and overhaul, and an electrical engineer who was thoroughly familiar with all accessories and equipment.

The whole problem of adequate maintenance of American equipment abroad has been aided greatly by the British decision to send "service teams" to America to be thoroughly schooled by various manufacturers in the repair and maintenance of their own types of aircraft.

Eight. For the various American manufacturers supplying planes to the British, "sister" firms have been appointed among Britain's aeronautical producers who are responsible for the assembly, overhaul and repair of a specific American product. Naturally, the fullest cooperation and mutual assistance between the "sister" firms of the two nations is essential. The American manufacturers can make a large contribution by seeing to it that their sister firms are provided with the most complete information possible. They should be sent operation manuals, standards books, all blueprints, complete stress analyses. The American producer also should see to it that the British concern receives promptly the same complete information on all accessories and every bit of equipment on the airplane, no matter where the origin of supply.

British Combine

These are the first of the Bell fighters to go into active service in England.

First three engineers to go to England for Bell: left to right: Robert Clydesdale, Arthur Fornoff, Kenneth Frey.

The Broader Concept of Service

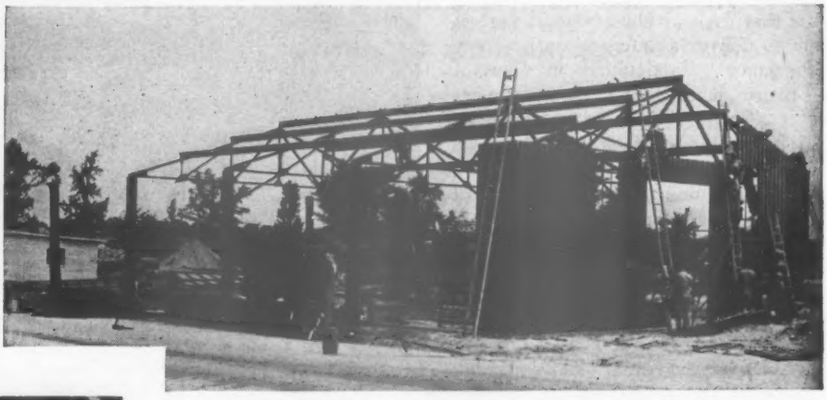
"Sales and service" has become a common phrase in modern industry. But service all too often is just an

(*Turn to page 188*)

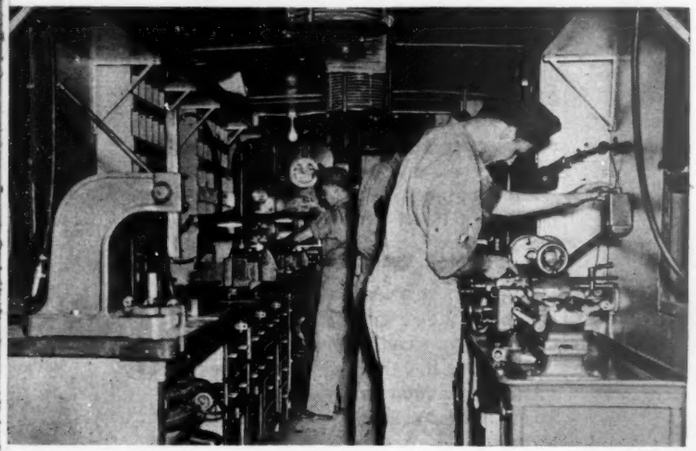
Maintenance on the Move

The Air Corps has new equipment and methods for servicing combat planes in the field.

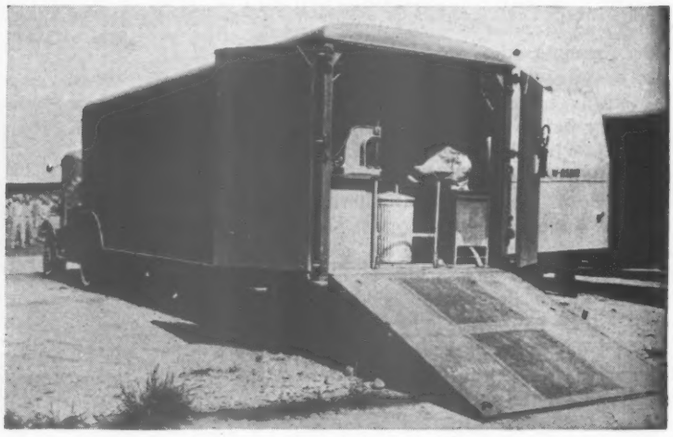
MAINTENANCE in modern war has by necessity been designed to keep pace with the rapid offensive tactics of the air forces. There was a time when large fixed depots with outlying semi-fixed sub-depots could maintain and supply tactical squadrons. From these the squadrons were serviced in order to remain operating and clear the ground ahead of the relatively slowly moving troops. But with mechanization these troops moved faster, and so did the air force and now so does the air force's maintenance.



The 4th Air Depot Group, organized at Patterson Field and transported South by huge motor trucks, erected a number of temporary buildings. Construction was done almost overnight. Buildings were used for a variety of Air Corps purposes.



Above view is an interior of one of the trailers shown at the right. A wide variety of machine shop and sheetmetal work can be done. In the left background is a Do-all machine, which is typical of equipment.



Exterior of portable machine shop of the 4th Air Depot Group, as used in Southern maneuvers.

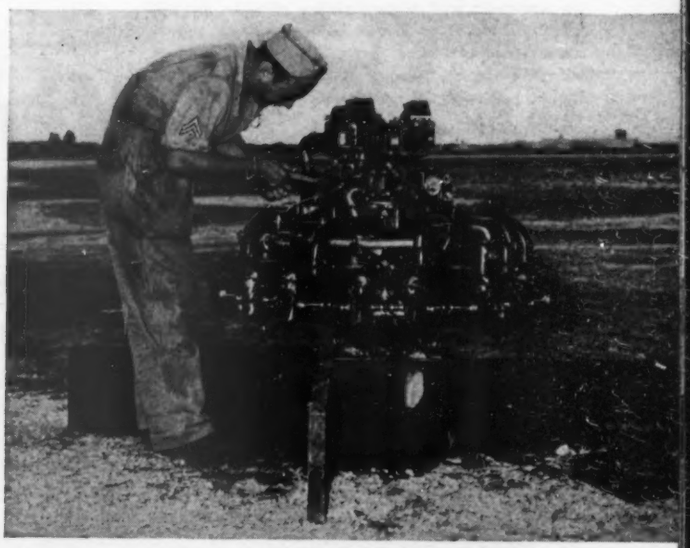
A portion of the mobile equipment just before it left Patterson Field for the Air Corps maneuvers.

The latest development in this race to keep abreast of the fighting units of the Army Air Corps is the Mobile Air Depot Groups—a mobile repair and supply unit designed to "roll along" behind the advancing front lines. It holds a unique place in the gigantic organization of the Air Service Command in that it functions in the theatre of operations, doing all but completely rebuild an airplane within shell fire of the enemy. Its purpose is to be a connecting link between the zone of combat and the zone of the interior.

Photographs on this page are of the 25th Air Base Group, regularly stationed at Orlando, Fla., which was attached to the Third Army in the Louisiana maneuvers. This is a tail assembly repair job.

This type of mobile machine shop is slightly smaller than that shown on the opposite page, but it is well equipped with tools necessary for light repairs which have to be made in the field.

To provide mechanics with more space, sheetmetal equipment was moved into lean-to tents next to mobile machine shops. These are not posed pictures, but actual work being done near Beaumont in September.



At Lake Charles, La., this practical engine stand was used during engine changes. The 25th Group comprised about 20 officers and 275 enlisted men. Service was given to both army and navy planes.

Method of Operating

The Air Depot Group is organized to install and then be prepared in a period of ten days, if necessary, to transport itself, or to be transported, to the next designated point of operation. In tactical situations where the advance is so rapid that even this period is too long, the units are "leap frogged" so that as one unit is being used another is in readiness in reserve to move ahead. While this is taking place the unit just operating is packed up and held in reserve to make a similar move. Thus with this speed maintenance is assured in any eventuality.

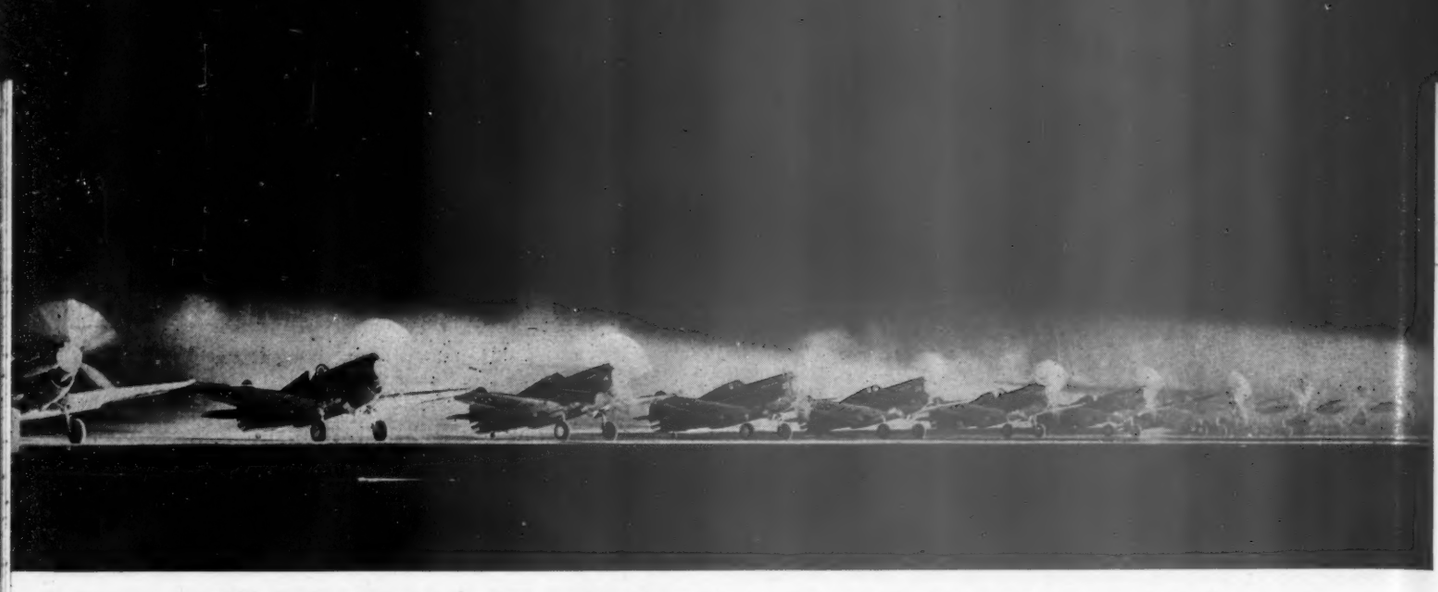
In combat the unit is able to perform all of the necessary maintenance work to meet the existing situation. It is responsible for supplying and repairing all of the aircraft that it is servicing as well as salvage parts from crashes. To do this a very flexible organization has been built around the necessary fundamentals in order to have equipment available under any circumstances. If tropical jungles are to be encountered it is obvious that the requirements are not the same as for far northern climates. However the machines for repairing and maintaining the planes are present for outfits serving in either location.

In addition to the supply of materials for the combat units the Air Depot Groups also supply the personnel required for operation. In case a plane and crew is lost by one of the squadrons, for instance, the officer in charge notifies the Air Depot Group of the personnel needed to fill the vacancy and the orders for the replacement are issued immediately. To keep a reserve pool available, officers and enlisted men are assigned to these depot groups and ordered to wait there for further orders assigning them to a combat unit.

These units serve four tactical groups including bombardment, pursuit,

(*Turn to page 166*)

Mechanics of the 47th Materiel Squadron making an engine change at Lake Charles, La. Temporary scaffolding was rigged from which a chain hoist was suspended. A considerable amount of portable field test equipment was used by these mechanics.



P-40's on the line warming up for a night flight. Mechanics work steadily night and day to keep these ships in action.

Men On The Ground

Maintenance men of the Air Corps are doing a vitally important job at every training and tactical field in the country. Work at Hamilton Field, California, is representative of that done at most of the larger pursuit fields where Base Engineering Officers are stationed.

This double dolly speeds propeller changes. The unit taken off the ship is swung on the shaft at the right, by means of an overhead chain hoist. The propeller now on the dolly is then put on the ship. The dolly has three rubber-tired wheels, can be pushed by men or towed by a tractor. Propeller tools are kept in the cabinet forming body of dolly.

Official U. S. Air Corps photos by 45th Air Base Photo Section.

ONLY a pilot appreciates good maintenance work. As he pursues his mission over rough mountains and turbulent seas he must know that his engine and plane will not force him down. Although it nestles in a sunny California valley, Hamilton Field is surrounded by treacherous mountain peaks and often by fog-filled valleys. Pilots of the 20th and 35th Pursuit Groups, who fly from this advanced tactical base, have learned to put confidence in their partners on the ground who work around the clock to keep the P-40's flying.

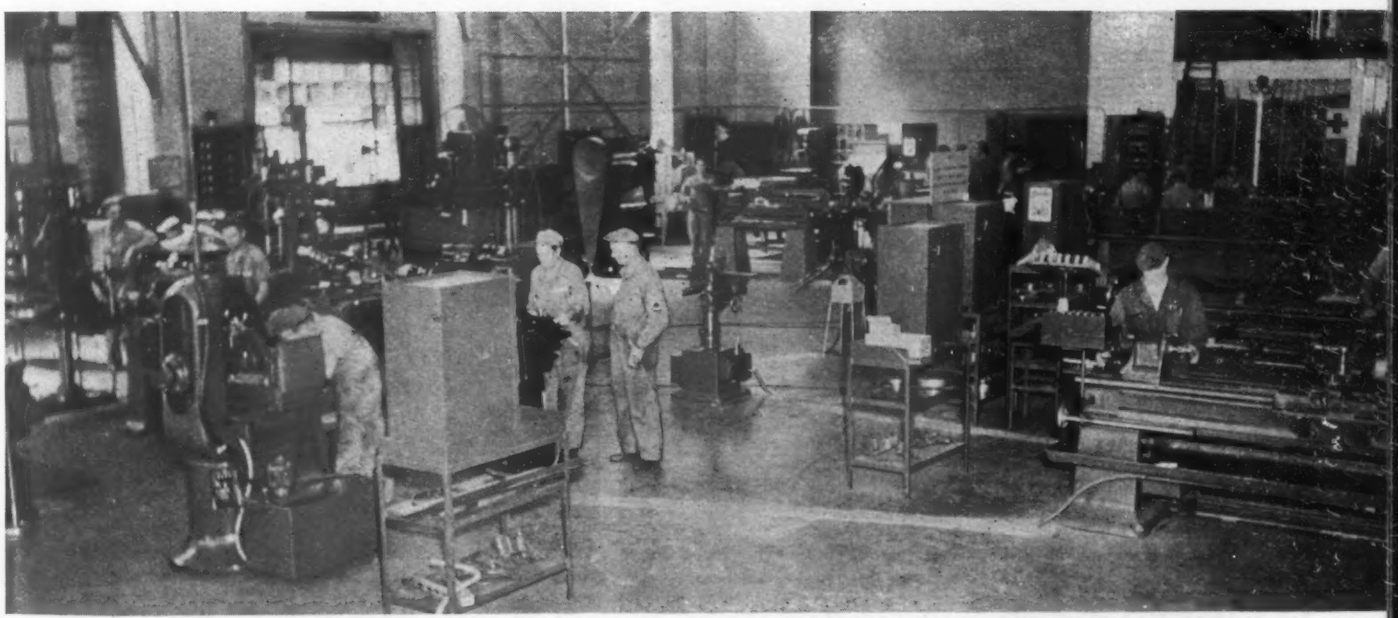
The combat ships at Hamilton Field must always be ready. One month, with only an hour's notice, ships, pilots and mechanics are whisked off to a temporary field somewhere in the mountains, from which they must carry on all operations. Another month the squadrons move to war games in the South or off to maneuvers elsewhere, a thousand miles or more from their base. The maintenance men must make sure that planes are always ready.

Photographs on these two pages show a few of the many jobs mechanics do at Hamilton Field. All pictures were taken for AVIATION by the Photo Section of the 45th Air Base Group of the U. S. Army Air Corps.

Left: sheetmetal mechanics are shown riveting a reinforcement on the gun cowling of a P-40. Parts for the new brace were assembled from blueprints and then installed.

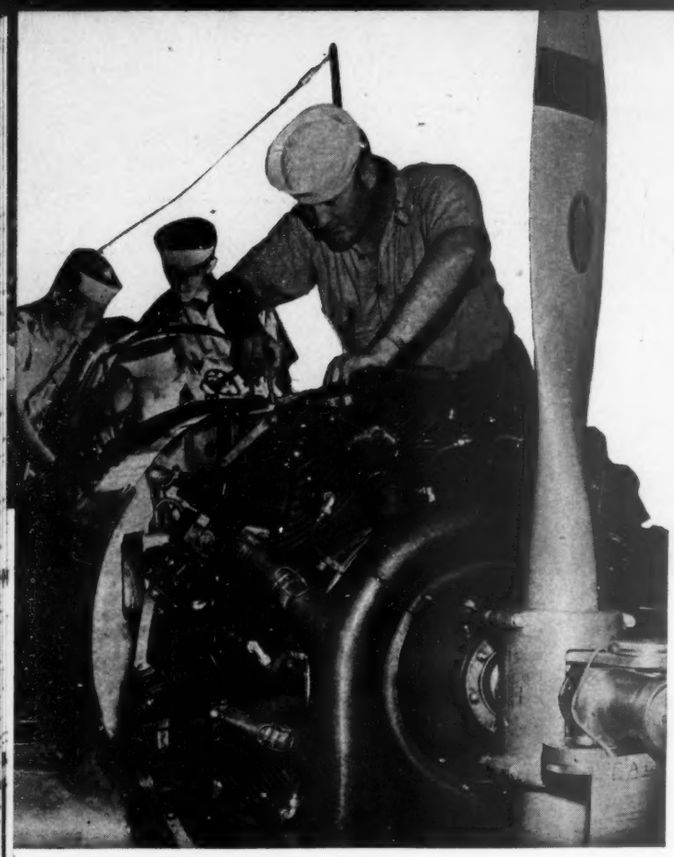
Typical of shop equipment is this precision engine lathe, operated by Pvt. Ted Rudnisky, which can be used for a wide range of work, from as large as turning contacts on propeller hubs or as small as putting 80 threads per inch on a small bolt.

at Hamilton Field



General view of the Base Engineering shop at Hamilton Field. This shop is clean, well lighted and equipped with lathes, radial drills, surface grinders and other machine tools and a variety of sheetmetal equipment. Officers are proud of the high caliber of work turned out.

This sturdy, 6-wheel truck was adapted for changing engines, both at the base and in the field. A sling is secured to the Allison engine which is swung free after all connections have been unfastened and the mount unbolted. Then the engine is reversed so that the rear of the engine goes on the truck first. The engine mount fittings are secured to the two horizontal members on the uprights at the left on the truck. The propeller shaft rests in the support now shown resting temporarily on the ground.

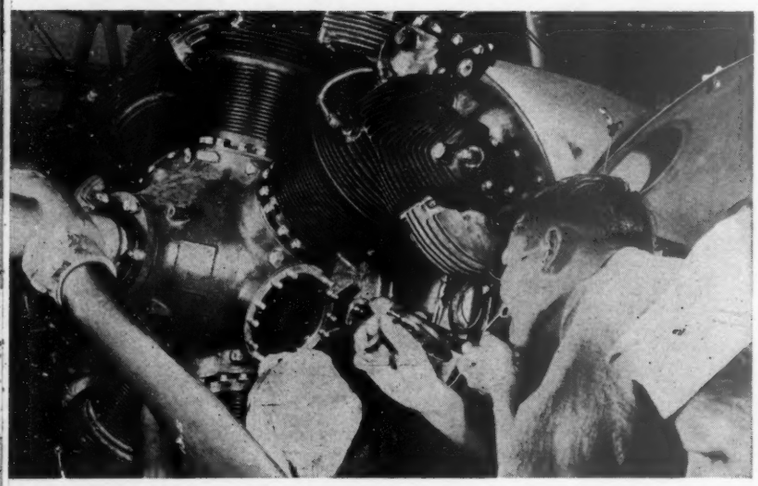


Corpus Christi

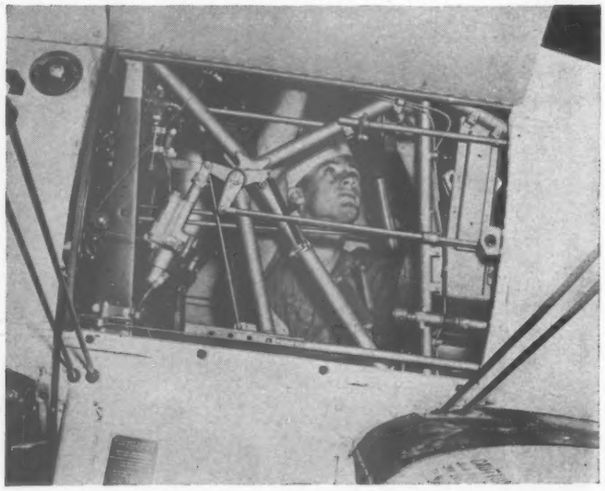
At its new Air Station in Texas the Navy has built a great, sprawling city of barracks, hangars and flying fields. In these two pages of photographs are shown some of the maintenance activities that keep Navy airplanes flying.

U. S. Navy official photographs

As each new airplane is received it is given an acceptance check. These mechanics are going over a new Curtiss trainer from propeller to tail.

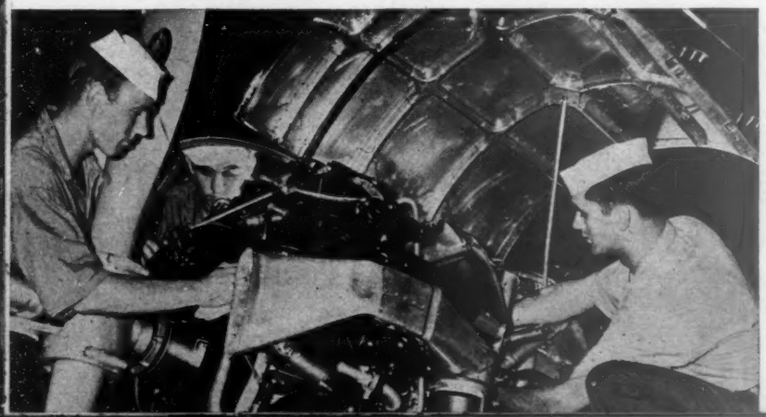


Emergency engine repair on a Stearman trainer. Unlike the Air Corps, which sends engines requiring major overhauls to central depots, the Navy does all engine work at each station, including the numerous Naval Reserve bases. Mechanics must learn to do all-around engine maintenance.



This mechanic is checking a turn and bank indicator line on a Navy Stearman trainer. A wide panel, which hinges at the top, can be opened for maintenance work. Because of rough treatment they receive, trainers are given daily inspections.

Another view during an engine check on an SNC Curtiss trainer. This engine cowling hinges at the top and can be lifted out of the way. The Navy uses many types of engines and mechanics must know each type.



Lubricating the landing gear of a Stearman trainer with a pressure grease gun. Due to the warm weather at Corpus Christi, maintenance can be carried on outdoors the year around.

Above: Navy mechanics checking and inspecting the hydraulic system of a SBC-4 Curtiss Scout Bomber.

Left: Start of general overhaul on a Curtiss Scout Bomber in the assembly and repair shop. Any kind of repair can be made.

Brake inspections are made at periodic intervals on all ships. This is a Navy Stearman trainer.

Inspection of an SBC-4. This complex maze of tubes, wires and controls shows why maintenance mechanics need specialized training. Many new mechanics are trained here.

A four-bladed test propeller is used for the ground run-in during engine tests. This engine has had a major overhaul.

One of the many types of airplanes operated at Corpus is the patrol bomber. This is an engine check on a PBY.

This we have, this we h

THERE is the right of a man to stand on his own two feet, and with his own hands and talents carve out a place for himself and his family.

There is the right of a woman to look hopefully ahead, to raise up her brood in dignity and self-respect, undictated to save by her own mother-wisdom and conscience.

There is the right of a boy to lead the hale, free life of boys, flying kites when the wind blows, playing cops and robbers when he wants, going to school when he must—and out of it all somehow shaping a future to a good pattern.

There is the right of a small child to its chance for health and love and laughter, to a good start to

GOODYEAR DEFENSE PRODUCT

ward who-knows-what fine and useful life in years to come.

Simple things, aren't they, these things that spell America and add up to freedom!

So simple, so wholesome, it seems daft that somewhere bombs scream down to blast them, tanks lunge to crush them, bullets fly to drive from the minds of men the idea that these *are* their rights, inalienable.

But the bombs do fall, the tanks do roll, the bullets do fly—and in such a world our only shield seems to be more bombs of our own with bombers to carry them, more tanks and the cannon to arm them, more bullets and faster guns to fire them.

So it is that from Goodyear factories meant for building things to enlarge life and make it better, now must flow in a swelling tide the things our country needs if we are to hold what we have.

Skills and facilities developed that a peaceful world might have better tires, floor coverings, soles and heels, transmission belts and a thousand like useful things, now focus on the making of barrage balloons, bomber wings and tails, bullet-puncture-sealing inner tubes and fuel tanks, gas masks, rubber tank track treads and a host of other Goodyear-made defense products.

This is no choice of ours — like yourself, we would far rather spend our days making this a land where life can be richer, liberty enjoyed, where the pursuit of happiness can go steadily on.

But when the decision lies between helping our government prepare for impregnable defense of such things, or running the risk of having them swept away, there is no option and we feel as we know you do.

That which we in America have, we intend to do our part to hold.

Compared with holding it, what else matters?

AMERICA MUST BE FIRST IN THE AIR

Unless and until America is the most powerful nation in the air, our safety, our freedom, and our standard of living will not again be what they have been in the past.

P. Litchfield

HELP "KEEP 'EM FLYING"

British Service Teams Study American Aircraft

Our aviation industry is engaged in a cooperative program with the British to improve handling of American flying equipment abroad—lease-lend program for small tools urged.

OFFICIALS of the British Air Commission acknowledged that a plan is already in operation which is designed to improve the maintenance and servicing of American flying equipment abroad.

Service teams of Royal Air Force enlisted mechanics are being trained in the assembly, repair and servicing of American equipment at various plants throughout the United States where airframes, engines, instruments and other accessories are in production for the British.

Each service team normally comprises six men, non-commissioned officers already highly trained and fully qualified in the R.A.F., one metal rigger (aircraft mechanic); two engine fitters (aircraft engine mechanics); one instrument maker; one electrician; one armorer. The team assigned to a particular type goes to the factory producing that type. They obtain living quarters in the vicinity and remain as long as is necessary to master their subject.

The metal rigger spends his time at the scene of fabrication and assembly, obtaining all the knowledge he can regarding the airframe assembly and all of its components. The two engine fitters study the method of mounting the powerplant, the location of engine accessories, features of installation, proper ways of servicing, checking, replacing minor parts and so on, then they go to the factory of the engine manufacturer. There they study the design and construction of the engine, as well as major repairs, overhauls and inspections. Wherever necessary they also travel to the plants of the suppliers of engine parts and accessories so that they will be completely informed on everything relating to the powerplant.

The instrument maker and electrician follow somewhat the same procedure. After familiarizing themselves with all the instruments and electrical equipment as installed in the completed aircraft, they visit in turn each of the manufacturers supplying such equipment to be instructed in the design, construction and repair of every part.

The armorer is concerned with the installation of armor plate, bomb racks, turrets, guns, ammunition boxes. His job, though as fully important as the others, usually does not require as much time. Therefore, there is not at present an armorer member of each team.

By early November, teams were hard at work with Lockheed Aircraft, North American Aviation, Glenn L. Martin Co. and Curtiss-Wright Airplane Division. Additional teams are being sent to plants of other manufacturers as rapidly as qualified men can be selected and transported to the United States.

In spite of the sizeable handicaps under which these men are working, it is noteworthy that all reports from the firms training the teams thus far have been enthusiastic over the spirit of these R.A.F. men, who are reported to spend 12 hours a day regularly at their job. They do not have unlimited funds at their disposal, and quarters are usually difficult to find in the neighborhood of our big aircraft plants, but with the cooperation of the firms and other assisting agencies most have been made fairly comfortable now.

The instrument men, particularly, have to travel great distances between their assignments and all of the men have to maintain an orderly accumulation of data in addition to their practical experience so that they may instruct others upon their return. The men in these teams are volunteers from service squadrons who have had long years of experience. They evidently have been selected with a great deal of care, to the end that they may not only absorb as much knowledge as possible here but can also impart their knowledge of American flying equipment to the combat squadrons concerned.

The project outlined is directed to-

(*Turn to page* 182)

British Combine Photos

From the "arsenal of democracy" comes this Douglas DB-7 shown being unloaded somewhere in England to join her aerial fighting forces. Some of the American planes have been put into the air within three days of their arrival by ship. The accompanying article discusses problems of adequate maintenance for such equipment abroad.

Mustangs

Range the Frontiers of Freedom

Just as the frontiers of America grew beneath the flying hooves of the mustangs, so today's frontiers of freedom are guarded by North American Mustangs—swift pursuits named for the hardy strain of American wild ponies.

These fleet, agile fighters, in active service with the RAF, are helping Britain attain complete supremacy in the air.

CURTISS-WRIGHT CORPORATION • *Propeller Division* • CALDWELL, NEW JERSEY
CLIFTON • PITTSBURGH • INDIANAPOLIS • BEAVER

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PROPELLERS

IN DEFENSE OF TRADITION

☆ America's traditions of freedom and democracy are today backed up by armed forces on land, on sea, and in the air.

Designed, perfected and fabricated in Breeze laboratories and factories, such developments as Radio Ignition Shielding, Flexible Conduit and Fittings, Multiple Electrical Connectors, Tie Rods, Armor Plate and Cartridge Engine Starters are among the many Breeze products to be found performing dependably in all three elements.

With four plants in operation, Breeze continues to play its part in today's tremendously increased defense program.

Breeze BREEZE MARK CORPORATIONS INC.

NEWARK, NEW JERSEY

Light Plane Maintenance

Lessons about light plane maintenance that have been learned through the C.P.T. Program.

By Donald C. Dobbyn, *Chief, Maintenance Section*
Civilian Pilot Training, C.A.A.

A FEW years ago, when an airplane was purchased, for either commercial use or pleasure, little thought was given to maintenance until the airplane had been in service for at least a year. The need for replacements and overhauls was then brought to the owner's attention with painful clarity, and gradually a consciousness developed that airplane design, operation, and maintenance are as closely allied as the "Three Musketeers." The lessons gained from those days, and the increase in the amount of flying during the last two years have resulted in many changes pertaining to these three musketeers—design, operation, and maintenance.

The national defense emergency, which necessitates the large volume of pilot training being performed by the Civilian Pilot Training Program of the Civil Aeronautics Administration, puts flying time on airplanes at a rate many times more rapid than previously. In order to keep these airplanes going, in this essential training program, it is necessary to pay much attention to maintenance. In view of the more concentrated use of airplanes now, with the attendant increase in required attention to maintenance replacements and overhauls, the impression might develop that there has been little improvement in the maintenance needs of the present-day airplane over the older models. However, a comparison of maintenance repair costs per flight hour readily reveals the improvement that has been made in all three musketeers—design, operation, and maintenance.

The manufacturer of an airplane must furnish a product which operates satisfactorily under the widest possible variety of conditions. Some of his airplanes will be operating from industry, sandy airports which rapidly wear engines and bearing surfaces. This condition indicates the value of such things as hinges with replaceable bushings or dust-proof ball bearings. Other airports are located where extremes of temperature are encountered, and cold engine operation is the rule. Our second musketeer, operation, is important here because engine wear must be prevented by avoidance of over-priming and care to warm up the engine, with external heating devices when necessary, before flight. Some of the manufacturer's airplanes will be operating from fields located 1½ miles above sea level where air is thin and engine powers are low, but where temperatures go to the two extremes. Many of his airplanes are used on rough auxiliary fields, which operation calls for sturdy construction and a frequent check-up on rigging. This sturdy construction, to take care of the rough auxiliary fields, must not result in too much weight which would be unnecessary on smoother fields.

The manufacturer must learn of all these difficult conditions and must incorporate in his airplane satisfactory means of surmounting them at a reasonable cost to the ultimate user. Much of this information he gains in the experimental laboratories and shops of his factories, but most of it must come from the field. Of course, over the past years, manufacturers were able to keep in fairly close touch with their relatively few customers, and from them they gained considerable volume of information and misinformation. The latter because the owner and operator of the airplane was not necessarily schooled in engineering or mechanics.

The present large volume of Government contracted and Government controlled flight training immediately made plain the necessity for overseeing the maintenance and operation of training aircraft in order to assure continued usefulness, at reasonable cost, of each piece of training equipment. In the Civilian Pilot Training Program a nation-wide network of maintenance supervisors has been stationed in the seven regions into which the country is divided. Each supervisor is responsible for the continued satisfactory operation of approximately 60 airplanes operated by some 12 flight contractors. These supervisors were selected because of their knowledge and qualifications as mechanics, and the eligibility requirements they have met are high; sufficiently high that we may put full credence upon the statements regarding mechanical conditions which they send in from their districts. These statements which accumulate in Washington

(*Turn to page 216*)

AIRWORTHY

MANY airport visitors who enjoy watching the big transport planes "take off" may not be aware of the interesting story of service and maintenance behind each liner which rolls up to the runway ready for flight.

Before the Inspector certifies a transport as "airworthy" in accordance with Civil Aeronautics Board and airline regulations, the ship has been through the most rigid inspection. Every inch has been gone over by master aircraft mechanics. Controls, landing gear, instruments, radio installation and motors have been tested by specialists and rechecked by inspectors.

Preparing an airliner for a flight is today a highly organized, systematic job. American Airlines, at the New York terminal alone, employ approximately 1000 men in the maintenance of transports. In the shops, motors are taken down, rebuilt, tested under elaborate controls. Engineering advances are continuously being built into the planes, and passenger ships actually grow better in use.

"The inherent utility and public service of air transportation," says President C. R. Smith of American Airlines, "creates increasing demand which will continue to call for larger, faster planes. Maintenance will become more and more exacting, will require constantly greater skill. It is a vocation for ambitious, intelligent men who have a background of sound technical training."

For such men, the future is bright in aviation.

ACADEMY OF AERONAUTICS, LaGuardia Field, New York
CASEY JONES SCHOOL OF AERONAUTICS, Newark, N. J.

COMPLETE TECHNICAL COURSES IN AERONAUTICS

C. S. Jones
President

ADVERTISEMENT NUMBER EIGHT OF A SERIES ALSO APPEARING IN TIME AND FORTUNE

Servicing Canadian Kinners

By Charles Sander,
Chief Engineer
Kinner Motors, Incorporated

To get to the hangar at the Windsor Mills, Quebec, training field, mechanics and pilots had to carve their way through this deep snow drift.

WHEN the war broke out the Canadian Royal Air Force numbered 3000 men, fliers and ground crew combined. Today it is well over ten times that figure and still expanding at a prodigious rate.

The accomplishment is one of the great sagas of the war. Starting from scratch all along the line, with green hands and with time and the elements against them, seldom have men triumphed over such overpowering odds.

Canada was primarily an agricultural nation and had no great supply of mechanically minded men to draw upon. Men who literally had never seen airplanes and stood in awe of them were taken from farms, forests and coal mines and trained as aircraft mechanics.

With time at a premium there was no opportunity for research or careful investigation. So Canada had to cut and try—with green hands with unfamiliar equipment—as it went along.

There were many mistakes and it was tough going for a while, but from it has come one of the world's great air forces.

This article deals with the maintenance of the Kinner engines that power the Fleet Finch II primary trainers which are being flown day in and day out under the British Commonwealth Air Training Scheme.

An unusual operation record is being written with the hundreds of Kinner engines employed in Canada. In the first place, Canada has demonstrated, and it is now an official order, that all Kinners operate a minimum of 640 hours between overhauls, instead of the customary 480-hour period.

In effect, this 160-hour boost, which amounts to a 33 percent minimum increase, gives Canada an extra Kinner engine for every three in service. Canada has set no limit on the maximum time between overhauls. This is subject only to the discretion of the local engineer.

Canada has built up this efficient record through a long and arduous development and educational program. A new conception of the operation of aircraft engines under severe winter conditions had to be written and a well-trained personnel, capable of avoiding well meaning but harmful mistakes, had to be developed.

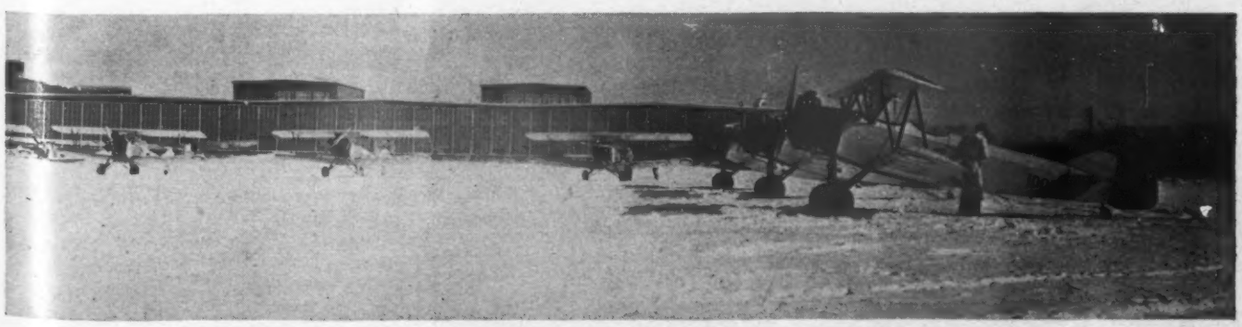
Many experimental cowlings, however, were tried by Fleet Aircraft, Ltd., in early installations of Kinner engines. One included five hoods that extended to the top of each cylinder head. Each hood had a door that could be opened and closed from the cockpit, with which the pilot could control the temperature of the engine.

What these doors actually did was to let all of the air flow around one side of the cylinder only, resulting in uneven expansion, with consequent operating difficulties and even piston seizures. In the correction of these difficulties the Kinner service staff worked in close cooperation with the engineering branch of the RCAF and with Fleet.

It was found that any unnatural

(Turn to page 194)

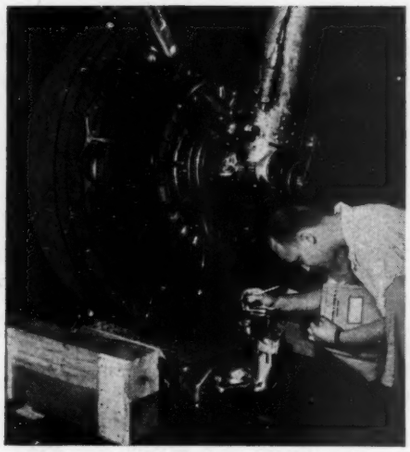
Snow plows must often be operated for several hours every morning before runways are clear enough for training.



Typical winter day at a Canadian training base, with Kinner-powered Fleet-Finch II's on the line.

More Flying Per Day For Airline Planes

Maintenance men are contributing greatly to national defense because they are making it possible to get more intensive use of airplanes than ever before in history. Airlines have fewer planes than are actually needed, but maintenance crews have speeded up their methods and by working around the clock are keeping air transports flying steadily throughout the country. Never before has airline maintenance been more important.



TWA's weight engineer Kirk Raynesford weighs the Stratoliner with two 15,000 lb. scales plus a suspended tail scale.

Northeast Airlines developed this field cart which has an automatic brake that operates as soon as handle is released.

Busy Joe Martin of American Airlines maintains the largest fleet of transports of any line in the world.

Doc Anderson of Chicago & Southern is proud these days of the brand new base at Memphis.

Newest large hangars in the country are at Washington, D. C. At present Eastern and Penn Central are sharing this hangar but soon each will have large space and American will also occupy a hangar. Penn Central is already moving its base from Pittsburgh to Washington.

American Airlines has developed a new maintenance dispatch system by which servicing is carried on whenever airplanes are on the ground. Major overhauls are done at the LaGuardia base, shown here. A DC-3 is getting a thorough going over.

James T. King, Western Air Lines maintenance superintendent, has worked out with United Air Lines the only complete interchange of airplanes now being used between two lines.

Trans-Canada is more than an airline these days. Its maintenance base in Montreal and shops elsewhere overhaul propellers, instruments and accessories for the Royal Canadian Air Force.

United Air Lines has always been a leader in communications. This is a test panel in the new radio-electric shop at Cheyenne. Bendix DF tester in foreground.

At Delta's new shops in Atlanta C. P. Lyle makes plaster molds from which sheetmetal parts will be drop hammered.

H. F. Clarke keeps Inland's fleet of Boeings operating smoothly between Cheyenne, Great Falls and Huron.

Newly appointed maintenance superintendent for All American Aviation is Edward D. Musser. Base is at Pittsburgh. The line operates a fleet of Lycoming-powered Stinson Reliants and has been sending engines to factory for overhaul. Beginning immediately, under Musser's direction, line will do all engine work.

Continental at Denver has much new equipment. Here R. C. Johnson, engine shop foreman, operates a piston ring lapping machine built here. An air-operated reciprocating piston rotates through a 40 deg. arc each stroke. Machine stops after set number of strokes.

The Birdmen's Perch

We've come to the conclusion that our public can't take it. First they were clamoring for really tough problems. So we ran them. Then what happens? The fellows who had been doing most of the yelling fold up and silently steal away. Only a few hardy souls, such as the fellow below, can answer those stickers. Shall we go back to diaper-days problems, boys?

Major Al Williams, alias, "Tattered Wing Tips,"
Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

WOOING THE MUSE DEPT.

There's something about a plane that moves more people to poetry! Here's the latest to reach our desk. It's from Miss Bonnie Walters of Omaha, Nebraska.

The plane in the hangar stretched its wings,
And gave a mighty yawn,
He thought as he wriggled his piston rings,
My, what a beautiful dawn!

He partook of his breakfast of gasoline,
And out on the runway he rolled,
Then, glancing to see if his face was clean,
Up into the air he strolled.

He impolitely scared a tree,
By zooming far too low,
Then looking up, what did he see!
It brought him grief and woe.

For soaring high above him,
He saw his girl friend, Jane,
She was acting coy with Tailspin Jim,
Oh, it gave him a pain.

So up he went with a mighty roar,
And knocked Jim in a spin,
He watched him hit the floor
And then, took Jane back down with him.

Jane thought that he was wonderful,
And softly rubbed wing tips,
She praised him till the little plane's heart,
Was doing backward flips.

The little plane was very gay,
His head was in a cloud,
Then he and Jane went off to play.
They both were very proud.

THIS MONTH'S BRAIN TWISTER

Robert Smith, of Hamilton, Ontario, is one of the fellows who thinks our "tough" problems are just sissies. So he sends in one of his own. What can you do with it?

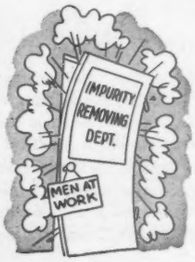
A flying hunter took off and started to fly due South. After he had traveled 100 miles he had seen nothing, so he turned and flew due East. At the end of 100 miles he spotted a bear on the ground so he landed and shot it. He then took off again and flew 100 miles back home. What was the color of the bear? (Ouch!)

IT PAYS TO BE CRITICAL

A great author once remarked that good literature often depended upon a man's ability to cut his own writing ruthlessly. The man, who could go through his own brain child, remove *every* extraneous word —*he* would have something worthwhile when he got through!

We use the same system in producing Gulfpride Motor Oil. We are constantly

critical of this oil. We are never satisfied with removing just enough impurities from it. We go even further and by a special process of refining—the Alchlor Process—we remove *more* of the carbon and sludge-formers that often can be so costly to an airplane engine. We think the success of Gulfpride Motor Oil proves that it pays to be mighty critical—especially of your own products!



WHOPPER OF THE MONTH

Dear Major,

I operate a loop-o-plane in a carnival. Maybe you've seen a Loop-o-plane. They're little four-seated buckets that whirl around on a pole. A motor revolves the pole.

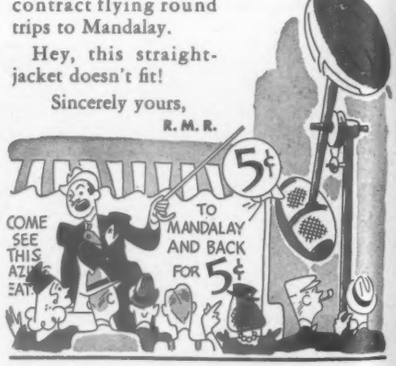
Well, one day I was cleaning up the motor, waiting for the evening trade to start, when quite by chance I spilled a little G.A.G. on

the motor—you'll notice I said *on* the motor. Just then a customer appears so I hop down and sell him a ride. Well, I no sooner touch that switch and turn my back than the danged thing whirls around twice and shoots the car up to substratosphere levels. After it circles it heads west at four hundred m.p.h. and disappears. Not having heard of a preceding similar situation, I set down to think and darned if after half an hour it doesn't zoom over the roller coaster and make the prettiest hook-on landing on its whirligig.

After the passenger recovered he filed suit for twenty grand, which just cleaned out my Irish sweepstake winnings. I was going to sue G.A.G. for underrating their products but I got a ten-year mail contract flying round trips to Mandalay.

Hey, this straight-jacket doesn't fit!

Sincerely yours,
R. M. R.



Gulf Oil Corporation and Gulf Refining Company . . . makers of

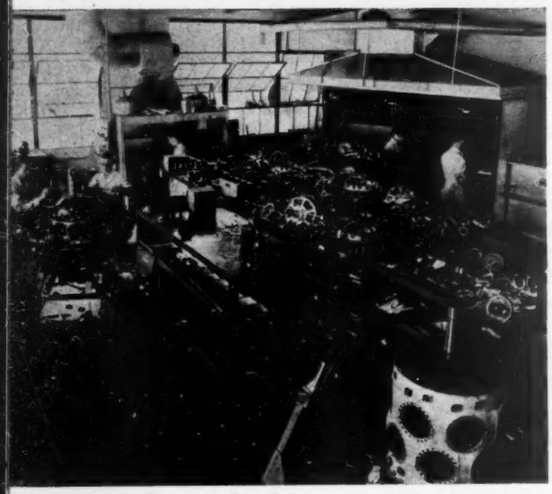
GULF AVIATION PRODUCTS

The essential margin of superiority that wins a war is necessarily the sum total of many component parts.
Value of the precise workmanship, long experience and unstinted care which the men of OHIO Seamless concentrate on the production of OHIO Quality Seamless Aircraft Tubing is best judged by performance of American built ships as they deliver their bomb loads - straight to the target.
Photo by courtesy of DOUGLAS AIRCRAFT COMPANY, INC., SBD Dive Bomber for U S. Navy and Marine Corps
CHROME
MOLYBDENUM
FOR
STRENGTH
LIGHTNESS
AND
SAFETY
The OHIO
SEAMLESS TUBE CO.
OHIO SPECIAL QUALITY
Shelby, OHIO

Mass Maintenance Methods

With 598 men servicing over 256 airplanes, this story of Chief Kidder's shops is especially noteworthy.

By Charles "Chief" Kidder, *Service Manager and Superintendent, Grand Central Air Terminal Engineering Officer, Cal-Aero Academy*



WITH every aircraft, aircraft engine, and aircraft accessory factory in the country straining to expand production to new records it is growing apparent that the biggest headache in the whole aviation industry before long will be the mass maintenance of all this equipment. This maintenance problem has developed first in the field of military pilot training and from this experience of servicing and maintaining trainers we can learn a great many lessons of value to all branches of maintenance work. The heavy end of the maintenance load fell on the training program because of the relatively greater volume of training planes which have been built to date, the intensive operation to which they have been subjected, and the abuse which has been handed to them by our embryo pilots.

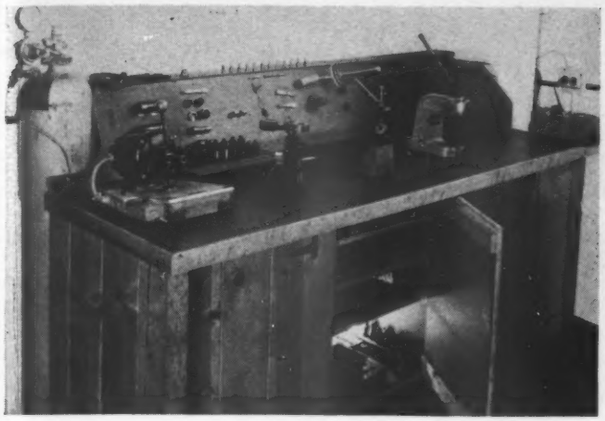
Left: engines are received and torn down in Plant 1.

Our organization maintains a total of 256 military planes, including spare engines, plus a heavy volume of commercial maintenance work. It is our job to maintain all the flying equipment operated by the several schools directed by Major C. C. Moseley, including the Cal-Aero Academy, Polaris Flight Academy, Mira Loma Flight Academy, and the commercial and Army business of Aircraft Industries Corp. We maintain more airplanes than any one commercial airline in the world. Including service crews at our four major operations centers we have a total of 598 men actively engaged in service and maintenance work. Of this number 46 men are assigned to strictly commercial maintenance work. Our operations are centered in two shops having a total floor area of about 25,000 sq. ft. and equipped with every tool and machine needed to do work to meet factory standards. We operate as a fully approved CAA Repair Station and must do all military work to meet military specifications and technical orders.

(*Turn to page 176*)

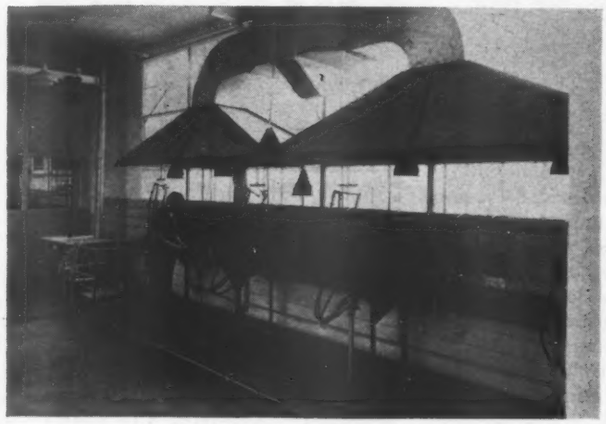
Left: inspection department with Magnaflux in far right corner. All racks are movable.

Right: final assembly at Plant 1, with parts racks on left. Engine stands permit engines to be locked in horizontal or vertical position. Tools are quickly reached from benches at right.



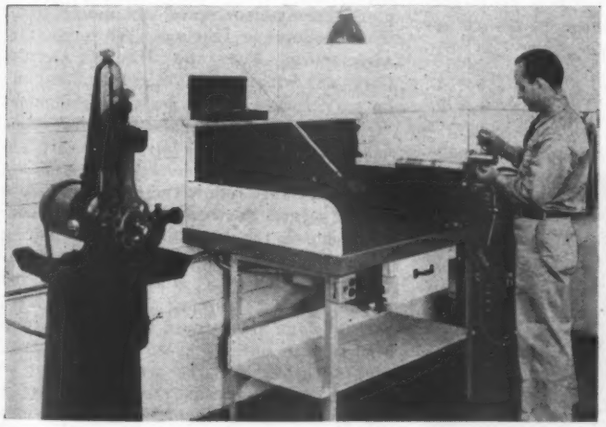
Bench for disassembling, testing and storing sparkplugs at Plant 1.

Accessory shop for magnetos, carburetors and ignition, Plant 1.

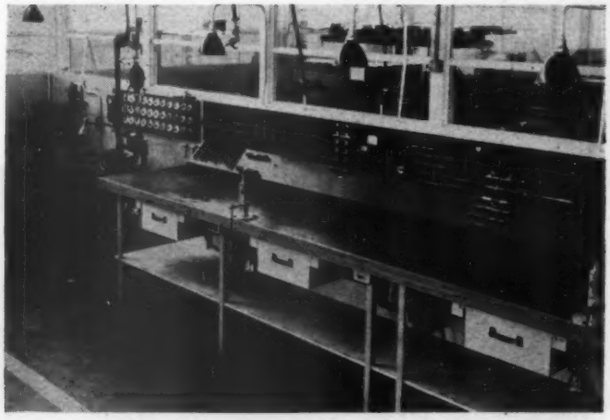


Degreasing and parts cleaning spray bench at Plant 2, Ontario, Cal.

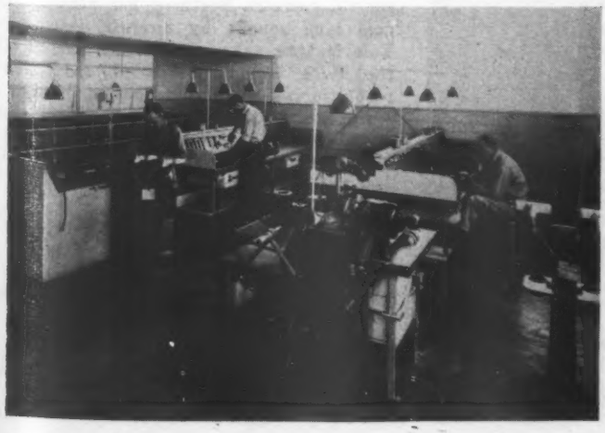
Cold solvent cleaning tanks. This and remaining photos are Plant 2.



Master rods are bored easily and accurately in machine at the left.

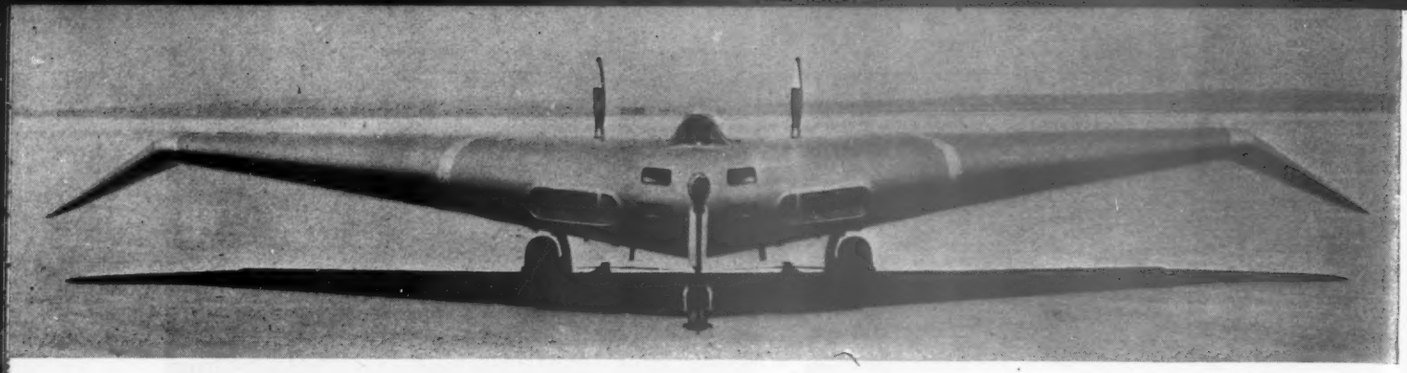


Hall eccentric cylinder grinding machine at left, and cylinder bench.



All standard accessories on training ships can be checked here.

Movable rack showing cleaned and inspected engine parts.



The Northrop "All-Wing"

By John K. Northrop, *President, Northrop Aircraft, Inc.*

IN an article appearing in AVIATION magazine in March, 1930, the writer described the first Northrop flying wing airplane to be given full scale flight tests. At that time the tests had been conducted over a period of a year and a half with excellent success. Recently a considerable amount of interest has been shown in tests which have now been in progress for a period of more than a year on an all-wing type plane of even more advanced design than that earlier model. As a result of the experience gained in designing and testing these two airplanes of radical type and the same general family, it is now possible to say that we are on the threshold of volume production of airplanes of the flying wing type. And it is not too much to say that this new family of airplanes, adaptable to almost all types of military and civil aircraft, will have a profound influence on all airplane design and on accepted performance standards.

The idea back of the designer's dream of an "all-wing" airplane is as old as bird flight itself. Birds in flight, and especially soaring birds, present a body in which non-lifting elements are suppressed to a high degree. It has been the goal of airplane designers to produce a plane in which every part exposed to the airstream would contribute to the lift of the machine in return for the drag caused. This effort has produced the cantilever monoplane, now almost universally accepted as a wing system of superior efficiency. And

The first Northrop wing, initiated in 1923 and first flown in 1928. Unlike the later wing this early model had movable tail controls on outrigger booms and but one engine.

Here is the inside story of the development of the Northrop "all-wing" airplane as told by the designer himself, John K. Northrop, President, Northrop Aircraft, Inc.

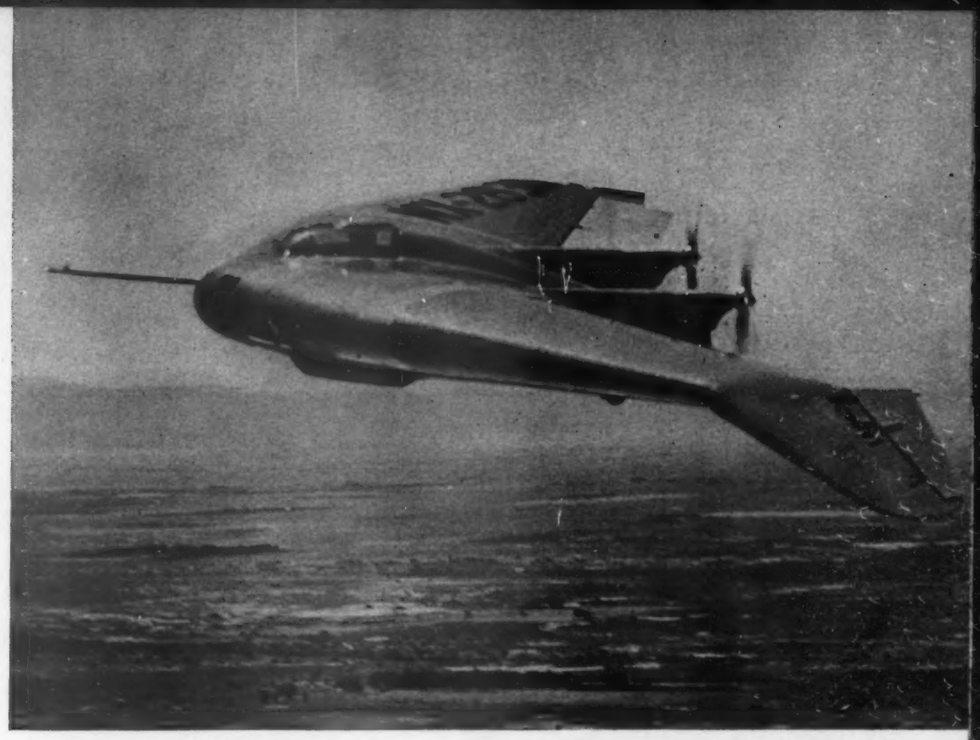
Jack Northrop is a unique figure in the field of aviation engineering. Perhaps no other designer has played such a vital part in such a wide range of aviation developments. Associated with Allan Lockheed in the early days of "after-the-war" aviation development, Jack Northrop designed the famous Lockheed "Vega" monoplane, the first successful commercial plane with monocoque fuselage. Through later associations with the United Aircraft Corp. and with Douglas Airplane Company he participated in the design development of the family of transport planes which has been accepted as standard throughout the world. All modern stressed-skin metal airplanes follow the pioneering work done by Jack Northrop in design and construction of the 1928-30 Northrop Flying Wing, which was of stressed skin, multicellular structure. His own Northrop Alpha, Beta, Gamma, Delta and A-17 attack plane also proved the stressed skin structure in notable speed and long-range flights throughout the world.

Jack Northrop was the first to apply the split trailing edge flap to a modern plane and to demonstrate its practicability.

With development of the "all-wing" plane which completely eliminates external control surfaces Northrop has achieved a goal long sought by aircraft designers. This feature, taken with other phases of the flying wing development, may well revolutionize all airplane design.

In the field of structures, with the multi-cellular stressed skin construction; in the field of control, with the split flap and the elimination of external controls; and in the general field of aerodynamics, through the development of the successful "all-wing" plane, Jack Northrop has contributed radical and revolutionary developments which stamp him as a unique figure in the world of aircraft design.

Airplane



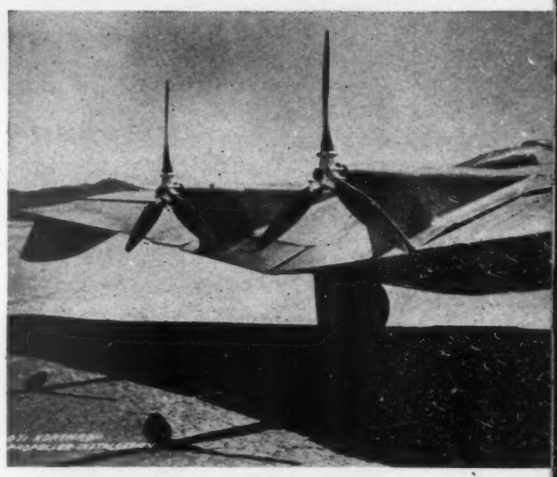
coupled with the development of the cantilever monoplane has been the perfection of the retractable landing gear in an effort to reduce waste drag. But we have still been faced with the problem of the fuselage, tail control and stabilizing surfaces, and engine nacelles. Experiments have been under way looking towards the elimination of nacelle drag through burying engines completely inside the wing. But the only hope for elimination of fuselage and tail drag has been to somehow "swallow" them into the wing.

Modern designers, including the writer, can claim no monopoly on the "flying wing" idea. Lippisch, in Germany, and Hill, in England, are among the designers who have built successful tailless planes. Even the first Wright biplane must be considered in this category in spite of its multiplicity of struts and wires, for it had no fuselage, carried the powerplant and pilot directly on the wing system, and was controlled longitudinally by a front elevator which was in fact a lifting wing surface.

But in all such craft developed in the past there has been a certain amount of parasite drag resulting from exposed fuselage and control surfaces so that full advantage was not taken of the flying wing principle. In the latest Northrop design there is no fuselage and no use of external fins, rudders or other aux-

(*Turn to page 184*)

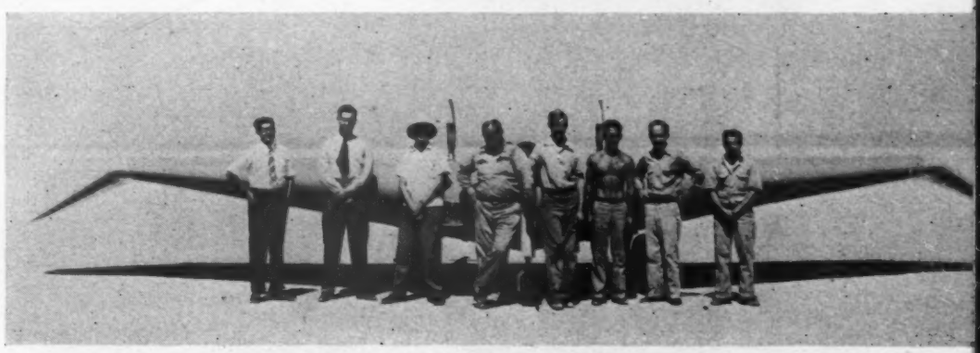
This flight view shows details of the drooping wing tips which provide rudder action. Pilot is said to have excellent visibility in this model although the designer states that on larger ships cockpit might be moved still farther forward.

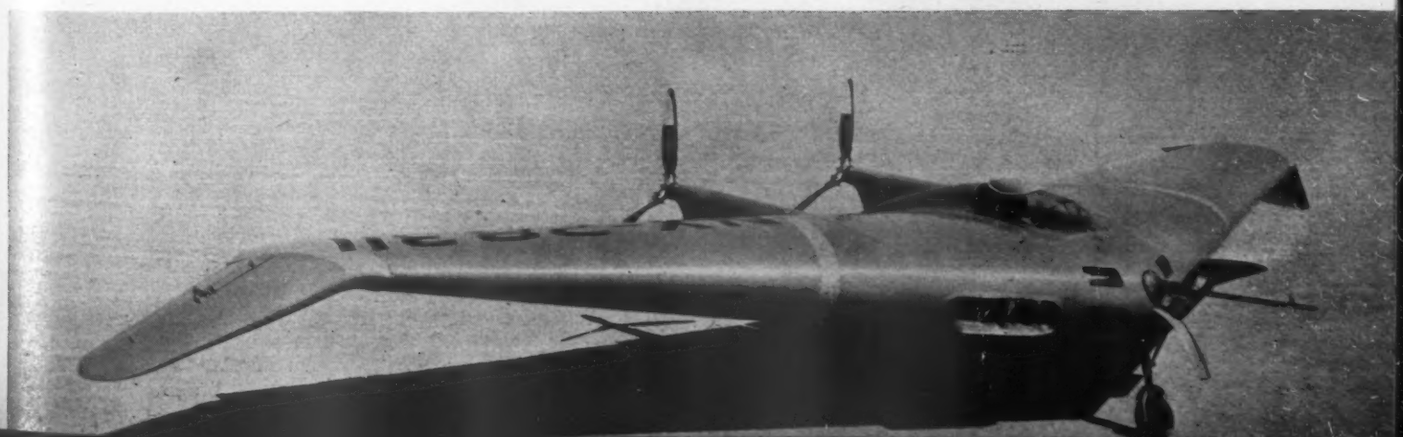


View at the right shows close-up of extension shafts that drive propellers from the buried engines. The "elevons" serve as both elevators and ailerons.

Another view showing air intake openings in leading edge of wing is at the bottom of the page.

Pilots and ground crew of the mystery ship kept it secret for over a year after first flight.





FOR MILITARY AND COMMERCIAL AIRCRAFT

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UNITED STATES STEEL

USS

"Teamwork For Production"

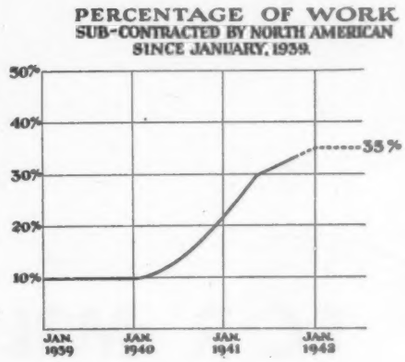
By Robert Monroe, *Director of Purchasing, North American Aviation, Inc.*

SPURRED by the deepening war crisis, our government has asked industry to perform a "miracle of production." We are told that our efforts must be so intensified as to double, triple, or even quadruple the volume of tanks, planes, and war weapons flowing to the battlefields.

For the young aviation industry this demand has been particularly difficult. In 1941 we have expanded production of American war planes to ten times what it was only three short years ago. Yet, on top of one miracle we are urged to perform still another and increase our production to 20 times what it was before the war emergency developed.

The reason is obvious. The military airplane is the spearhead of modern warfare. It is the sharp point which drives to the vitals of enemy resistance and opens a way for older and slower methods of combat. Air power is the vital factor in our formula for victory and so we must produce airplanes at a speed never before thought possible.

If this miraculous feat is to be performed it will be achieved only through the miracle of teamwork which will make it possible for the aviation industry of this country, in cooperation with government and with other industries, to make use of existing tools,



facilities and reservoirs of skilled workers, to achieve the maximum immediate result in expanded production without having to wait for the completion of new factories, the construction of new machine tools, and the training of new men. One formula for such a cooperative effort is sub-contracting. By breaking down the complete airplane into the maximum number of component parts and items of equipment, we are able to spread the manufacture of such items throughout the industrial life of the entire nation.

But sub-contracting has two sides. There are obvious advantages to the scheme of spreading our production problem, and there are some serious disadvantages, not all of them obvious. To overcome these difficulties we must rely on the miracle factor in our formula, the human element of teamwork and cooperation with each other in order to achieve a common, supreme purpose.

Immediate expansion of production is the major advantage of sub-contracting. Theoretically it is possible to allocate almost half of the work of building an airplane to plants which have previously been engaged in other work. Thus we would simply send production blueprints and specifications, along with a contract specifying the number of parts required, date delivery is required, and amount we will pay for the work, to a factory which was not too busy with other work to undertake our parts order. This might be a manufacturer of automobiles, refrigerators, or radios. It might be an independent machine shop, an accessory manufacturer or a toy maker. The theory of marshalling hundreds of such shops into an army of aircraft parts producers is an attractive one. It is easy to picture an overnight expansion of the aircraft production effort. Our imagination leaps to the possibility of a great host of such plants feeding in parts and assemblies to a few central aircraft assembly centers out of which roll the completed planes for our military services.

And there are other points favoring sub-contracting. As we gear our industrial effort to war needs there occur inevitable dislocations. Priority control of essential materials cuts down employment in many industries that have been producing for peace-time needs. Workers are laid off and whole towns suffer an economic blight if no war work is immediately available for the plants formerly engaged in non-defense production. Extension of sub-contracting offers a method of counteracting this economic dislocation. By sending orders for aircraft parts to areas formerly engaged in civilian production work it is possible to avoid the social and economic ills resulting from migration of workers from one area to another. Local merchants and business institutions, local schools and civic organizations, local labor, industry and political procedures are all maintained on an even keel. It is quite obvious that the benefits of an efficient sub-contracting program are of basic importance to the whole nation, as well

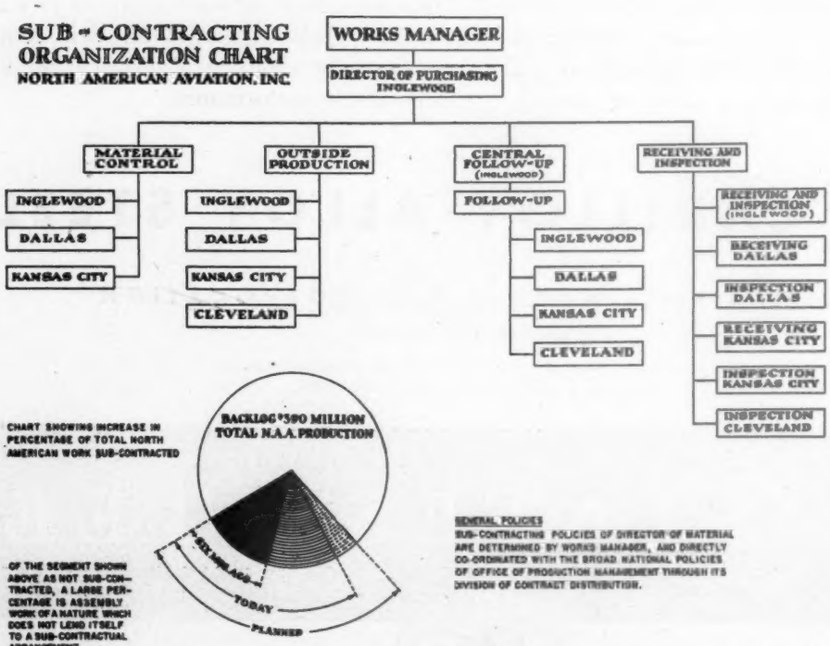
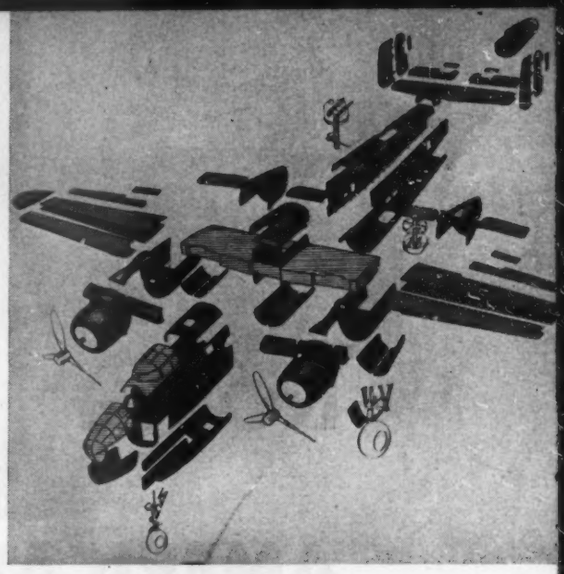


CHART SHOWING INCREASE IN PERCENTAGE OF TOTAL NORTH AMERICAN WORK SUB-CONTRACTED
BACKLOG $390 MILLION
TOTAL N.A.A. PRODUCTION
SIX MONTHS AGO
TODAY
PLANNED
OF THE SEGMENT SHOWN ABOVE AS NOT SUB-CONTRACTED, A LARGE PERCENTAGE IS ASSEMBLY WORK OF A NATURE WHICH DOES NOT LEND ITSELF TO A SUB-CONTRACTUAL ARRANGEMENT.

Multiple gang cutting tool set-up on lathe work which is operating on a hydraulic cylinder in the North American plant. Such tooling is difficult to find among sub-contractors except in the automotive industry.



Breakdown of the B-25 medium bomber showing sub-contracted parts. Dark and light-shaded areas are parts and assemblies made by Fisher Body Div. of General Motors. White areas indicate parts sub-sub-contracted by Fisher—landing gears, propellers, gun turrets. The only parts built and assembled in North American's Kansas City factory are shown cross-hatched.

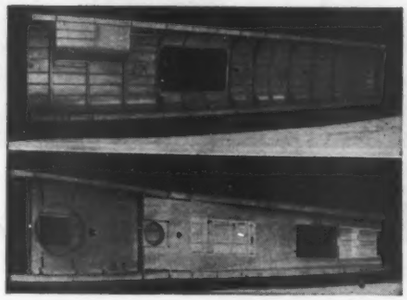
as being of paramount importance in securing immediate stimulation of our production effort.

But like every good thing in life, this sub-contracting scheme is not to be successfully accomplished by over-night, spur-of-the-moment action. We have succeeded to date because we have proceeded step by step, through a process of trial and error education, and with the close cooperation of everyone concerned. There have been many major problems to face. It is not at all easy to find plants that are capable of making aircraft parts to the required precision standards. Even the materials used in airplane manufacture, such as magnesium and aluminum alloys, are strange to most available shops. So we have had to conduct a very thorough program of investigation of all prospective sub-contract plants. We have had to study financial and labor background as well as the physical shop facilities and the availability of trained craftsmen. We have to allow for the possibility that a sub-contracting plant might experience financial failure while in the midst of executing an important contract. And it is possible that some labor trouble in a small plant, remote from our assembly lines, would rob us of important parts at a critical time. So we must do an intelligent job of "qualifying" all firms who enter into our sub-contract team. And once associated together in the production effort, we have to seek the utmost cooperation with all such plants in order that our flow of parts may be efficient and uninterrupted.

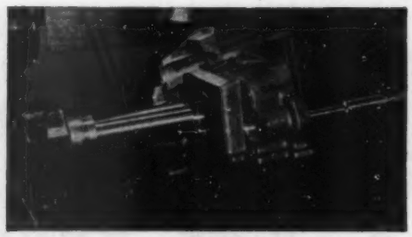
Following selection of a sub-contractor we have many mutual problems. His employees must be trained to understand all the special problems of producing parts for us. This involves tooling, jigs and fixtures, inspection, etc., and is in itself an important and time-consuming operation.

As we shift the production of parts and assemblies to sub-contractors we face a major problem in providing a sufficient stock of such parts to keep

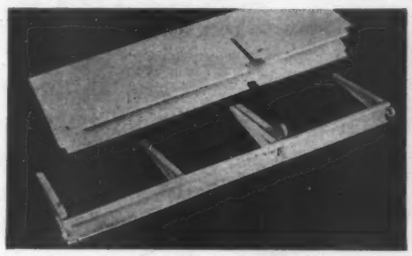
(Turn to page 96)



Bottom and top fuselage sections ready for the master fuselage jig. Breakdown of this type permits a great deal of sub-contracting.



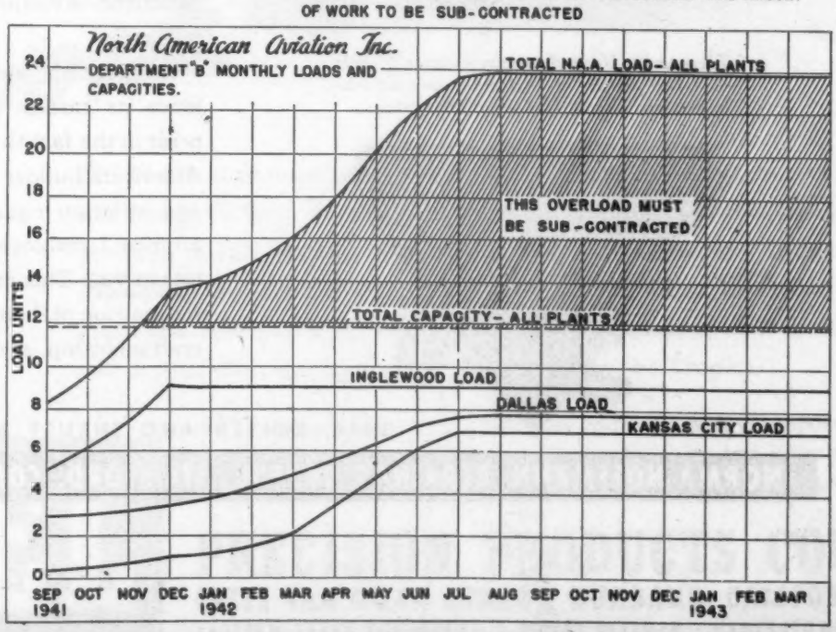
Many machined parts, such as this massive part shown in a boring set-up, suit themselves to sub-contracting in small machine shops.



Another of the many sub-assembly parts which may be farmed out.

Engine nacelles are formed in several sub-assemblies which also may be handled by sub-contractors.

THIS IS AN EXAMPLE OF THE DEPARTMENTAL LOAD STUDIES WHICH DETERMINE THE AMOUNT OF WORK TO BE SUB-CONTRACTED



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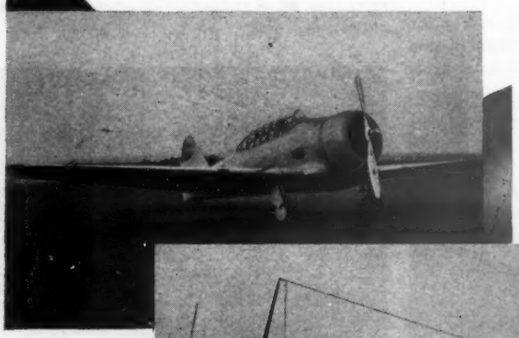
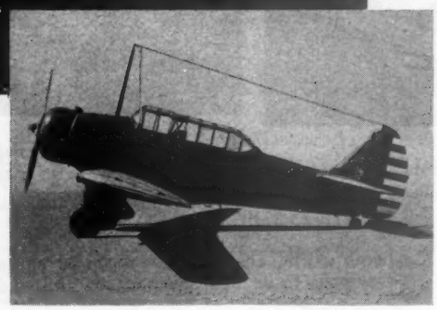
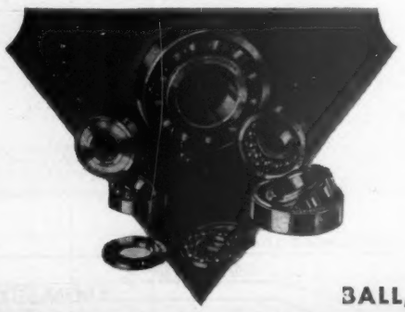




These earlier North American Aviation Models —NA-49 and BT-9 Trainers—were featured in previous Norma-Hoffmann advertising.



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Missouri Pacific Railroad
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Ray-O-Vac Company
Richards & Conover Hardware Co.
St. Louis & San Francisco Railroad
Schooley Printing and Stationery Co.
Sewall Paint Co.
South-West News Co.

NEW JERSEY

Aircraft Radio Corp.
Air Cruisers Inc.
Air Associates Inc.
Aluminum Co. of America
American Gas Accumulator Company
American Oil & Supply Co.
Breese Corp.
Barnard Mfg. Corp.
Celluloid Corp.
Coast Cable Co.
Curtiss-Wright Corp.
Dunlop, Wm. G., Co.
Dupont, E. I. De Nemours Company, Inc.
Elastic Stop Nut Corp.
Eclipse Aviation Div.
General Ceramics Co.
Groov-Pin Corp.
Heinemann Electric Co.
Isolantite, Inc.
Keuffel & Esser Co.
Kidde, Walter & Co., Inc.
Magnus Chemical Co., Inc.
Marlin-Rockwell Corp.
National Lock Washer Co.
Pioneer Instrument Div.
Pyrene Mfg. Co.
Pollak Mfg. Co.
Roebling's, J. A. Sons Co.
Roller-Bearing Co. of America
Switlik Parachute & Equip. Co.
Thiokol Corp.
Tieflex Metal Hose Co.
West Jersey Paper Mfg. Co.
Worthington Pump & Mach. Corp.
Wright Aeronautical Corp.
Weston Electrical Instrument Company

NEW YORK

Aero Spark Plug Co., Inc.
Aerial Machine & Tool Co.
Aluminum Co. of America
American Cord & Webbing Company
Agfa Ansco Corp.
American Hard Rubber Co.
Air Reduction Sales Co.
American Motor Products
American Can Company
Anemostat Corp.
American Cyanamid & Chemical Co.
Anthony, W. S. Co.
American-La France & Foamite Corp.
Ashwell, Thomas & Co.
Atlantic-Pacific Mfg. Corp.
B G Corporation
Bell Aircraft Corp.
Bendix-Export Corp.
Blumenthal, Sidney & Co.
Bowen Products
Brewaiter Aeronautical Corp.
Cambridge Inst. Co.
Cameron, R. W. & Co., Inc.
Clarastat Mfg. Co., Inc.
Calculagraph Company
Carbide and Carbon Chemicals Corporation
Corning Glass Works
Carborundum Company
Crucible Steel Company
Chicago Pneumatic Tool Co.
Columbia Steel Corporation
Cork Insulation Company
Curtiss Propeller Division
Dunlop Tire & Rubber Co.
Dzus Fastener Co.
Eastman Kodak Company
Endicott Forging & Mfg. Co., Inc.
Edo Aircraft Corp.
Fischer, Chas., Spring Co.
Fairchild Aerial Camera Corp.
Federal Bearings Co., Inc.
Gould Storage Battery Corp.
Garlock Packing Company
Gredag Corporation
General Chemical Company
Graybar Electric Company
General Electric Company
Gould Storage Battery Corp.
Harrison Radiator Corp.
Henry Forge & Tool, Inc.
Hewitt Rubber Corp.
Houde Engineering Corp.
Hunter Sash Company
Ingersoll-Rand Company
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International Nickel Co., Inc.
International Standard Electric Corp.
International Business Machines Corp.
International Projector Corp.
Irving Air Chute Co.
Jaeger Watch Co., Inc.
Johns-Manville Company
Kemp, W. H. Company
Kollsman Instrument Co.
Kirkman Engineering Corp.
Liberty Accessories Corp.
Lear Developments, Inc.
Liquidometer Corp.
Linde Air Products Co.
Linzer, David & Sons, Inc.
McGraw-Hill Publishing Co.
McKesson & Robbins Inc.
Mercury Aircraft Inc.
Mill Factor Products Co.
National Carbon Co., Inc.
New York Central Railroad
Numberall Stamp & Tool Co.
National Lead Company
Ozalid Corporation
Oakite Products, Inc.
Parker-Kalon Corp.
Roll-Label Manufacturing Co.
Rosen, A. W. & Co.
Ra-Ce Tool & Metal Stamp. Co., Inc.
Ranger Engineering Corp.
Rolled Metal Sections Co.
Reinbold Publishing Corp.
Simmonds Accessories, Inc.
Scintilla Magneto Co., Inc.
Spriesch Tool & Mfg. Co.
Standard Gauge Co.
Stimpson, Edwin B. Co.
Stewart Hartshorn Co.
Strippit Corporation
Star Machine Mfgrs., Inc.
Shore, The Mfg. Co.
Sperry Gyroscope Co., Inc.
Telephonics Corp.
Thomas Publishing Co.
Ulmer, A. J. Co.
United Aircraft Corp.
U. S. Steel Corp.
U. S. Gauge Co.
Vanderbilt, R. T. Co., Inc.
Wales Dove-Hermiston Corp.
Williams, J. H. & Co.
White, S. S. Dental Mfg. Co.
Westermann, B. Co., Inc.
Waldorf Mechanical Laboratories
Warren McArthur Corp.

OHIO

Addressograph Co.
Aero Instrument Co.
Air-Maze Air Filter Corp.
Aluminum Co. of America
Apex Machine & Tool Co.
American Hardrubber Co.
Auld, D. L. Co.
Austin Co., The
Avon Tool & Machine
Baltimore-Ohio Railro
Buckeye Portable Too
Cincinnati Machine & Supply Co.
Cincinnati Time Reco
Champion Machine & Forge Co.
Chesapeake & Ohio R
Columbus Metal Prod Inc.
Consolidated Mfg. Co
Cleveland Pneumatic
Continental Carbon,
Dayton Mfg. Co.
Dill Mfg. Co.
Diebold Safe & Lock
Electric Vacuum Clea Co., Inc.
Federal Machine & Welder Company
Firestone Tire & Rub
Formica Insulation C
Frigidaire Corp.
Fyr-Fyter Co.
General Tire & Rubbe
Goodrich, The B. F.
Goodyear Tire & Rub Co., Inc.
Goggie, The Parts Co
Grimes Mfg. Co.
Husband Aircraft Specialties, Inc.
Hansen Manufacturin
Hyland Machine Co.
International Flare-Signal Co.
Koehler Tool & Mfg.
Kline Mfg. Company
Lincoln Electric Com
Leece Neville Co.
Lear Aviation Co.
Lamson & Sessions
Libbey-Owens-Ford Glass Co.
Monmouth Products
Moore Eastwood & C
Marquette Metal Prod
National Bronze & Aluminum Co.
Ohio Seamless Tube
Packard Electric Co.
Parker Appliance Co.
Pump Engineering Service Corp.
Pollak Steel Co., The
Price, Sam J.
Perry-Fay Company
Romec Pump Compa
S. A. E. Steels
Service Tool & Engineering Co.
Standard Aircraft Products, Inc.
Steel Products Engineering Co.
Timken Roller Beari
U. S. Rubber Produc
Van Dorn Iron Works
Variety Aircraft Corp
Weatherhead Co., Th
Weldon Tool Co., Th
Western Automatic Machine Screw Co

OKLAHOMA

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OREGON

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PENNSYLVAN

Aero Supply Mfg. Co
Aluminum Co. of Am
Allegheny Steel Co.
American Chemical
American Window G
American Cable Co.
Anchor Packing Co.
Bond, Chase Co.
Budd, Edward Mfg. C
De Sanno, A. P. & S
Disston, Henry & Sc
Fleetwings, Inc.
Grammes, L. F. & S
Jessop Steel Co.
Kellett Autogiro Cor
Kopp Glass, Inc.
Leeds & Northrup Co
Lord Manufacturing
Linear Packing & R
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McCroskey Tool Corp
National Tube Co.
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Supply Company
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Pitney-Bowes Postage
Meter Company
Poulsen & Narden Tool
& Die Works
Product Engineering Co.
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Russell Mfg. Company

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Schrillo Tool &
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Schwabacher-Frey Company
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Sears-Roebuck & Company
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Singer Sewing Machine Co.
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Sierra Sanitary Mfg. Co.
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Smith-Emery Company
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Soister, E. L. Company
Solar Aircraft Company
Southern California Bag Co.
Southern California
Disinfecting Co.
Southern California Gas Co.
Southern California Foundry
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Stationers Corporation
Standard Felt Company
Standard Fence Company
Standard Oil Company
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Sterling Electric Motors, Inc.
Sullivan Fence Company

Sun Lumber Company
Sutorbilt Corporation
Swedlow, Dave, Corp.
Swift & Company

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Texas & Pacific Railroad Co.
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Thompson Glass & Paint Co.
Tibbetts-Westerfield
Paint Company
Todd Sales Company, The
Tollar Mechanical Works
Trulove's Transfer
Turco Products, Inc.

Underwood-Elliott-Fisher Co.
Union Hardware & Metal Co.
Union Pacific Railroad
Union Transfer & Storage Co.
United Motors Service, Inc.
United States Bag &
Supply Company
United States Flexible
Metallic Tubing Co.
United States Gauge Co.
Universal Carloading &
Distributing Company
Utility Electric Steel Foundry

Victor Belting & Rubber Co.
Victor Welding Equipment
Company
Viking Pump Company
Vogue Composition Co.

Wabash Railway Company
Wallace, J. D. & Company
Wardrobe Linen Supply Co.
Warman Steel Foundry
Warner & Swasey Company
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Warren & Bailey Company
Wagner Electric Corporation
West Disinfecting Company
Western Auto Supply Co.
Western Electric Company
Western Galvanizing Co.
Western Hardwood
Lumber Company
Wiley Machine Co., Inc.
Wilson Paper Company
Westinghouse Electric Co.
Wolverine Tube Company

Yocum, Sam

Zellerbach Paper Company
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ALABAMA

Ingalls Iron Works
Kilby Car & Foundry Co.

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American Tube Bending Co.
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Bronson, Homer D., Co.
Corbin Screw Co.
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Colt's Patent Fire Arms
Mfg. Co.
Chance-Vought Aircraft Co.
Chandler-Evans Co.
Chase Brass & Copper
Co., Inc.
Eastern Machine Screw Corp.
Fafnir Bearing Co.
Hamilton Standard
Propeller Division
Landers-Frary-Clark
Laminated Shim Co., Inc.
Lewis Engineering Co.
Manning, Maxwell &
Moore, Inc.
New Departure Mfg. Co.
Norma Hoffman Bearings
Corp.
Pratt & Whitney Aircraft
Division
Rockbestos Products Corp.
Stanley Insulating Co.

Seamless Rubber Company
Stanley Works, The
Scovill Manufacturing Co.
Torrington Co., The
United Aircraft Corp.,
Exp. Division
Veedor-Root, Inc.
Vought-Sikorsky Aircraft Div.

DELAWARE

National Vulcanized Fibre Co.
Wilmington Fibre
Specialty Company

ILLINOIS

Automatic Screw Machine
Products
Abbott Laboratories
Acme Industrial Co.
Acme Steel Company
Adjustable Clamp Co.
American Chain & Cable Co.
American Automatic Elec.
Sales Co.
American Phenolic Corp.
American Stock Gear Co.
Armstrong Bros. Tool Co.
Arens Controls
Automatic Screw Products
Askania Regulator Co.
Bastian-Blessing
Bauer & Black
Barber-Colman Company
Belden Mfg. Company
Besley, Chas. H., & Co.
Binks Manufacturing Co.
Bloxham Aero Mfg. Co.
Burgess, C. F. Laboratories
Chicago & North Western R.R.
Chicago Metal Hose Corp.
Chicago, Milwaukee &
St. Paul Railroad
Chicago Rock Island R.R.
Chicago Screw Company
Cornell Forge Company
Crane Company
Dearborn Chemical Co.
Dietzgen, Eugene Co.
Fairbanks Morse & Co.
Felt & Tarrant Mfg. Co.
Gaertner Scientific Corp.
Ideal Commutator
Dresser Co.
Illinois Central Railroad
Independent Pneumatic
Tool Co.
Jones, Howard B., Co.
Jefferson Electric Co.
Kropp Forge Company
Kellogg Switchboard
Supply Co.
Lens Electric Co.
L'Hommedieu, Chas. F.
& Sons Co.
Littlefuse Laboratories
Leonard, G. R. & Co., Inc.
Lange, Henry G., Machine
Works
Lincoln Schleuter Floor
Mach. Co.
Mansure, E. L. & Co.
Magnaflux Corporation
Micro Switch Corp.
Miller-Bryant-Pierce Co.
Ohmite Mfg. Co.
Onsrude Machine Co.
Pyle National Co., The
Pheoll Mfg. Co.
Quickwork, Co., The
Runzel Cord & Wire Co.
Ryerson, J. T., & Son, Inc.
Seaman Paper Co.
Shafer Bearing Corp.
Stewart-Warner Corp.
Steel Sales Corp.
Shakeproof Lock Washer Co.
Sciaky Spot Welder Co.
Speedway Mfg. Co.
Stewart Die Casting Div.
Whitney Metal Tool Co.
Wittek Manufacturing Co.

INDIANA

Adams & Westlake
Allison Engineering Co.
Aluminum Co. of America
Bendix Products Division,
South Bend
Chicago Telephone &
Supply Co.
Delco-Remy Division
Diamond Chain & Mfg. Co.
Electronics Laboratories, Inc.
Mallory, P. R. & Co.
Staley Mfg. Corporation
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KANSAS

Aircraft Steel and Supply Co.

KENTUCKY

American Air Filter Co.
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LOUISIANA

Cuban-American Sponge Co.
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Wellington Sear Co.

MARYLAND

Anchor Post Fence Co.
Bendix Radio Corp.
Engineering & Research
Corp.
Griffith, W. C.
Hibline, J. Edw. Co.

MASSACHUSETTS

Amesbury Metal Products
Aerovox Corp.
Anthony Machine &
Electric Works
Boston Auto Gauge Co.
Boston Insulated Wire &
Cable Co.
Boston Gear Works
Howes, S. M. Co.
Kelly, George J., Inc.
Lundquist Tool & Mfg. Co.
Moore Drop Forging Co.
Relief Printing Corp.
Thomson, Judson L.,
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United Carr Fastener Corp.
U. S. Automatic Box
Machinery Co.
Vultex Chemical Co.
Vellumoid Co., The

MICHIGAN

Aeroquip Corporation
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Beecher, Peck & Lewis
Berry Bros.
Bohn Aluminum Co.
Chandler-Groves Co.
Chrysler Corp.
Continental Motors Corp.
Commonwealth Brass Co.
Detroit Steel Products Co.
Douglas, H. A. Mfg. Co.
Dow Chemical Co.
Ex-Cello Corp.
Eaton Mfg. Company
Electric Auto-Lite Company
Flex-O-Tube Company
Fisher Body Works
Gregory Mayer & Thom Co.
General Motors Corp.
Gairing Tool Co.
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Hydraulic Brake Co.
Hall, C. M., Lamp Co.
Koebel Diamond Tool Co.
Michigan Seamless Tube Co.
Neilson Chemical Co.
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MINNESOTA

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English Bros. Machinery Co.
Faeth Co., The
Gateway Chemical Co.
Inman Powell Co.
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Langdon Supply Co.
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Mines Equipment Co.
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Wright Aeronautical Corp.
Weston Electrical
Instrument Company

NEW YORK

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American Hard Rubber Co.
Air Reduction Sales Co.
American Motors Products
American Can Company
Anemostat Corp.
American Cyanamid &
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American-La France &
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International Standard
Electric Corp.
International Business
Machines Corp.
International Projector Corp.
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Johns-Manville Company
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Kirkman Engineering Corp.
Liberty Accessories Corp.
Lear Developments, Inc.
Liquidometer Corp.
Linde Air Products Co.
Linzer, David & Sons, Inc.
McGraw-Hill Publishing Co.
McKesson & Robbins Inc.
Mercury Aircraft Inc.
Mill Factor Products Co.
National Carbon Co., Inc.
New York Central Railroad
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Ozalid Corporation
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Parker-Kalon Corp.
Roll-Label Manufacturing Co.
Rosen, A. W. & Co.
Ra-Ce Tool & Metal
Stamp. Co., Inc.
Ranger Engineering Corp.
Rolled Metal Sections Co.
Reinhold Publishing Corp.
Simmonds Accessories, Inc.
Scintilla Magneto Co., Inc.
Spriesch Tool & Mfg. Co.
Standard Gauge Co.
Stimpson, Edwin B. Co.
Stewart Hartshorn Co.
Strippit Corporation
Star Machine Mfgrs., Inc.
Shore, The Mfg. Co.
Sperry Gyroscope Co., Inc.
Telephonics Corp.
Thomas Publishing Co.
Ulmer, A. J. Co.
United Aircraft Corp.
U. S. Steel Corp.
U. S. Gauge Co.
Vanderbilt, R. T. Co., Inc.
Wales Dove-Hermiston Corp.
Williams, J. H. & Co.
White, S. S. Dental Mfg. Co.
Westermann, B. Co., Inc.
Waldorf Mechanical
Laboratories
Warren McArthur Corp.

OHIO

Addressograph Co.
Aero Instrument Co.
Air-Maze Air Filter Corp.
Aluminum Co. of America
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Production

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Avon Tool & Machine Co.
Baltimore-Ohio Railroad
Buckeye Portable Tool Co.
Cincinnati Machine & Supply Co.
Cincinnati Time Recorder Co.
Champion Machine & Forge Co.
Chesapeake & Ohio Railroad
Columbus Metal Products, Inc.
Consolidated Mfg. Co.
Cleveland Pneumatic Tool Co.
Continental Carbon, Inc.
Dayton Mfg. Co.
Dill Mfg. Co.
Diebold Safe & Lock Co.
Electric Vacuum Cleaner Co., Inc.
Federal Machine & Welder Company
Firestone Tire & Rubber Co.
Formica Insulation Co., Inc.
Frigidaire Corp.
Fyr-Fyter Co.
General Tire & Rubber Co.
Goodrich, The B. F. Co.
Goodyear Tire & Rubber Co., Inc.
Goggie, The Parts Co.
Grimes Mfg. Co.
Husband Aircraft Specialities, Inc.
Hansen Manufacturing Co.
Hyland Machine Co.
International Flare-Signal Co.
Koehler Tool & Mfg. Co.
Kline Mfg. Company
Lincoln Electric Company
Leece Neville Co.
Lear Aviation Co.
Lamson & Sessions Co., The
Libbey-Owens-Ford Glass Co.
Monmouth Products Co.
Moore Eastwood & Co.
Marquette Metal Products Co.
National Bronze & Aluminum Co.
Ohio Seamless Tube Co.
Packard Electric Co.
Parker Appliance Co.
Pump Engineering Service Corp.
Polak Steel Co., The
Price, Sam J.
Perry-Fay Company
Romec Pump Company
S. A. E. Steels
Service Tool & Engineering Co.
Standard Aircraft Products, Inc.
Steel Products Engineering Co.
Timken Roller Bearing Co.
U. S. Rubber Products, Inc.
Van Dorn Iron Works
Variety Aircraft Corp.
Weatherhead Co., The
Weldon Tool Co., The
Western Automatic Machine Screw Co.

OKLAHOMA

Macklanburg-Duncan Co.

OREGON

Pacific Spruce Company

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Aero Supply Mfg. Co., Inc.
Aluminum Co. of America
Allegheny Steel Co.
American Chemical Paint Co.
American Window Glass Co.
American Cable Co.
Anchor Packing Co.
Bond, Chase Co.
Budd, Ed. G. Mfg. Co.
De Sanno, A. F. & Son, Inc.
Disston, Henry & Sons
Fleetwings, Inc.
Grammes, L. F. & Sons, Inc.
Jessop Steel Co.
Kellett Autogiro Corp.
Kopp Glass, Inc.
Leeds & Northrup Company
Lord Manufacturing Co.
Linear Packing & Rubber Co.
Mine Safety Appliance Co.
McCrosky Tool Corp.
National Tube Co.
Pennsylvania Railroad
Phosphor Bronze Smelting Co., The
Pittsburgh, The Stamp Co.
Rohm & Haas Co., Inc.
Safetee Glass Company
Synthane Corporation
Shallcross Mfg. Co.
Summerill Tubing Company
Superior Steel Corporation
Universal-Cyclops Steel Corp.
Westinghouse Electric & Manufacturing Co.
Wiedmann Machine Works

TEXAS

Ahlanger, Max Company
Briggs-Weaver Machinery Co.
Bradley, Allen Company
Baldwin-Duckworth Division
Becket Electric Co., Inc.
Continental Screw Company
Cannon Electric Development Co.
Dixie Disinfecting Company
Dorsey Co., The
Engineering Sales Company
Eagle Lock Company
Eggelhof Engineers
Gulf Oil Company
Gisholt Machine Company
Hirsig, A. H.
Hengy Electric Co., J. M.
Hunter-Hayes Co.
Harter, C. J., Machinery Co.
Hamilton-Huster Machinery Company
Harvey Hubbel Company
Kearney & Trecker Corp.
Layne Texas Company
Louden Machinery Corp.
Lunkenheimer Co.
Lamson & Sessions Co.
McArdle Equipment Co.
McDonald, B. F. Co.
Magnolia Brush Mfg. Co.
Magnolia Airco Gas Products Company
Motor Parts Depot
Miller & Miller Motor Freight Lines
Nelson Electric Supply Co.
Ohmite Mfg. Company
Parker Griffith
Penny, Sam H.
Preston Machine Tools Sales, Inc.
Product Sales Corporation
Pittsburgh Plate Glass Co.
Rogers Printing Co.
Southwest Airmotive Co.
Smith, J. Earl
Texas-Pacific Railroad
Van Horn, Oliver H. Co., Inc.
Weiner Lumber Company
Wessendorf, Nelms & Co.
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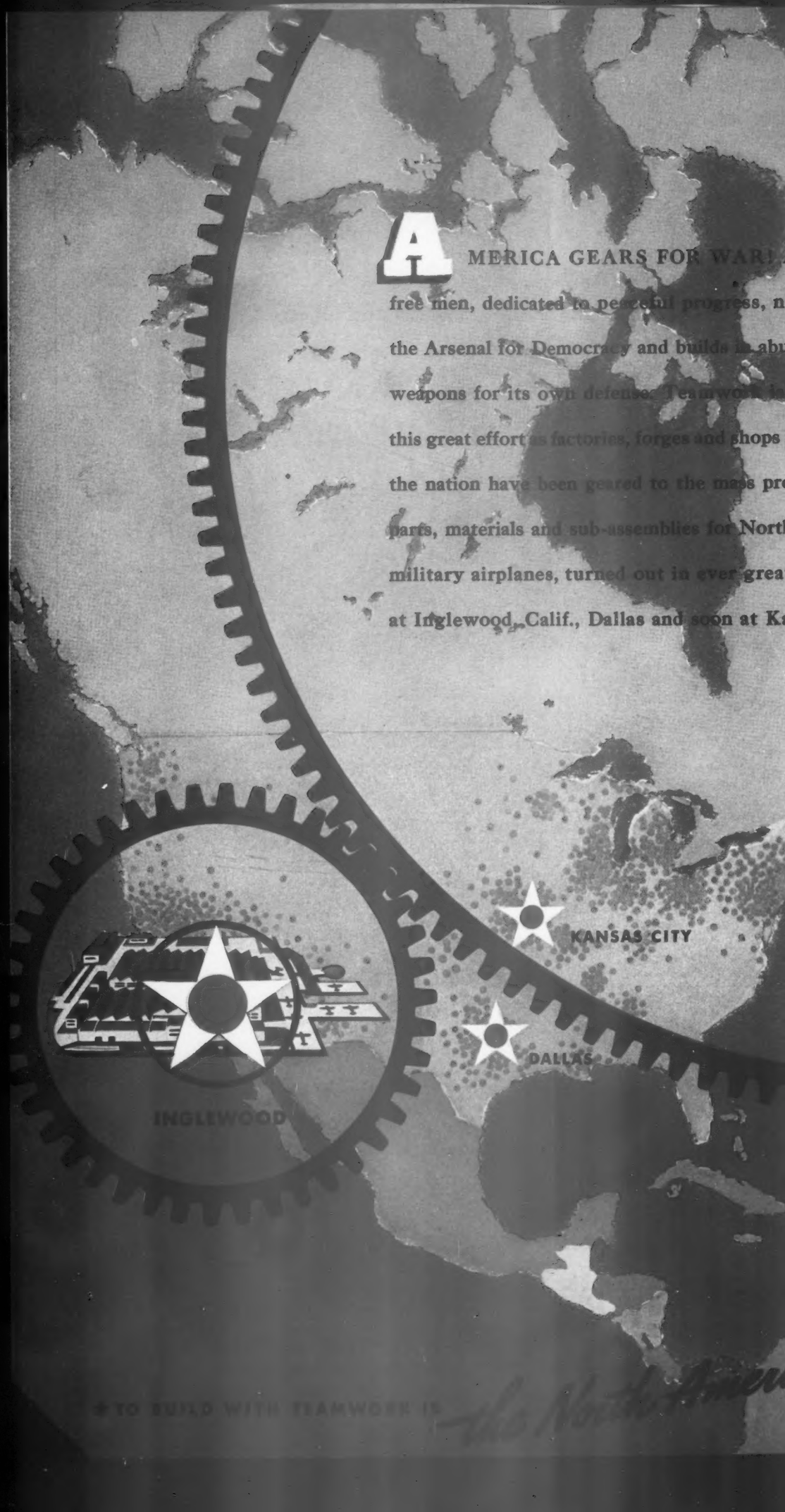
Oilgear, The Company
Shallcross Controls, Inc.
Young Radiator Company

VERMONT

Jones and Lamson Machine Co.

MERICAN WAY ★


AMERICA GEARS FOR WAR
free men, dedicated to peaceful progress, n
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weapons for its own defense. Teamwork i
this great effort as factories, forges and shops
the nation have been geared to the mass pro
parts, materials and sub-assemblies for North
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KANSAS CITY
DALLAS
INGLEWOOD
TO BUILD WITH TEAMWORK IS

R WAR! A nation of
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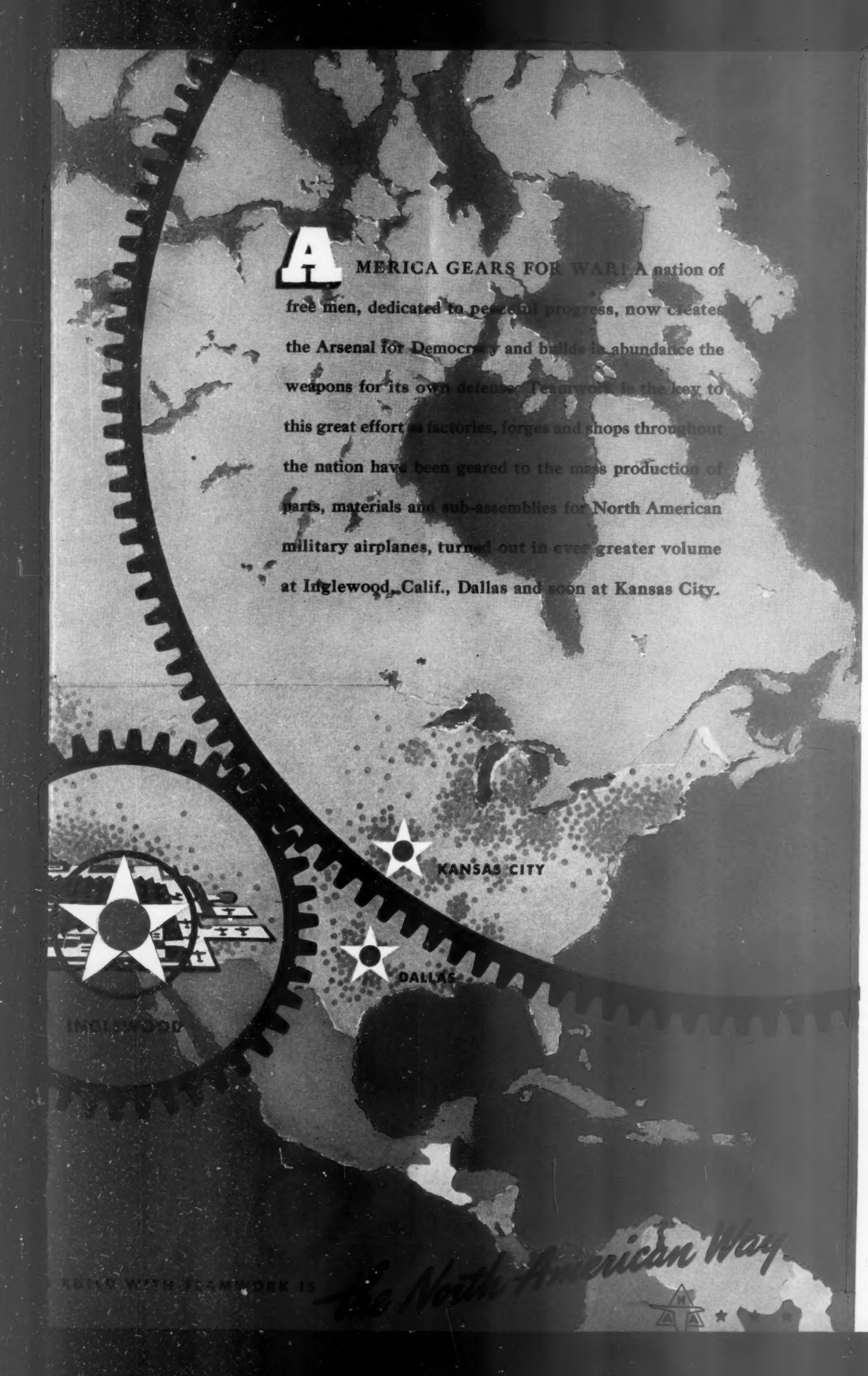
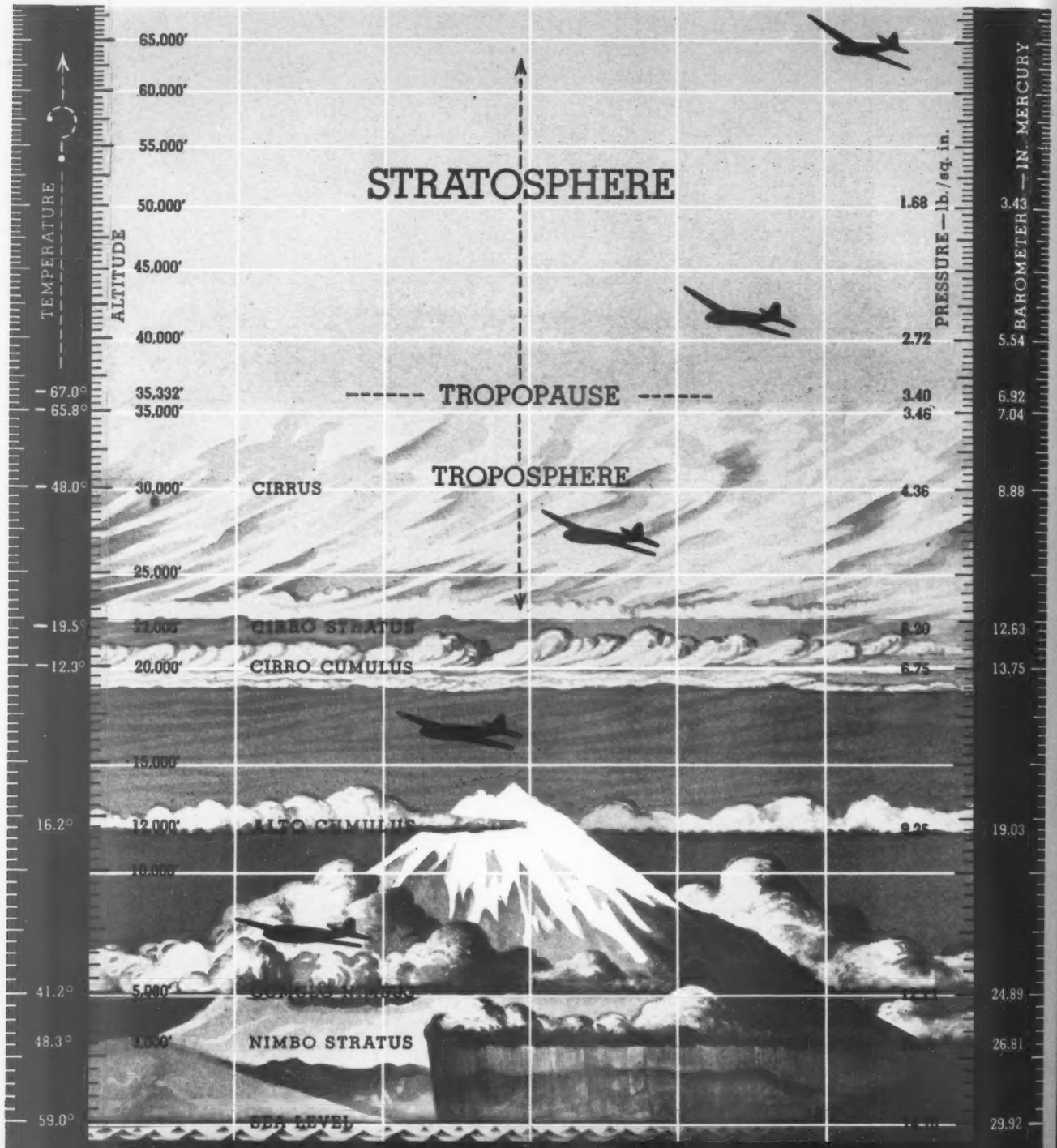
soon at Kansas City.
erican Way


AMERICA GEARS FOR WAR! A nation of
free men, dedicated to peaceful progress, now creates
the Arsenal for Democracy and builds in abundance the
weapons for its own defense. Teamwork is the key to
this great effort as factories, forges and shops throughout
the nation have been geared to the mass production of
parts, materials and sub-assemblies for North American
military airplanes, turned out in ever greater volume
at Inglewood, Calif., Dallas and soon at Kansas City.
KANSAS CITY
DALLAS
INGLEWOOD
BUILD WITH TEAMWORK IS
TEMPERATURE
67.0°
65.8°
48.0°
19.5°
12.3°
16.2°
41.2°
48.3°
59.0°
OIL



AIRESEARCH TODAY GRAPHS THE FLIGHT PICTURE OF TOMORROW

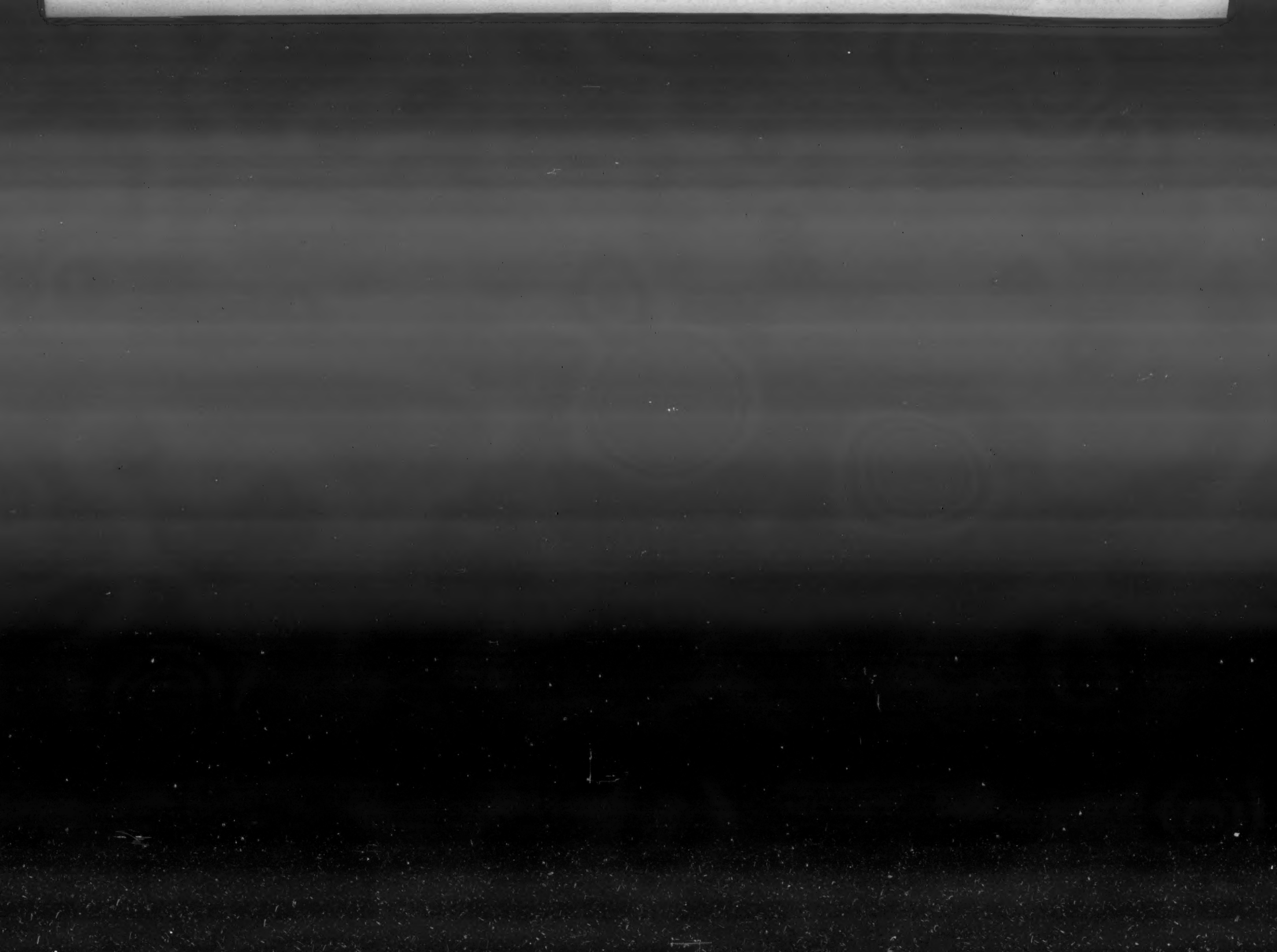
High into the rarified air of the Stratosphere will go the military planes, passenger transports and cargo carriers of the future. Airesearch engineers are constantly working with "high altitude" air created in their laboratory, contributing their knowledge to new applications and designs. We welcome the opportunity to assist in your development and production problems.

AIRESEARCH MANUFACTURING CO.

Los Angeles Municipal Airport, Sepulveda Blvd., at Century, Inglewood, California

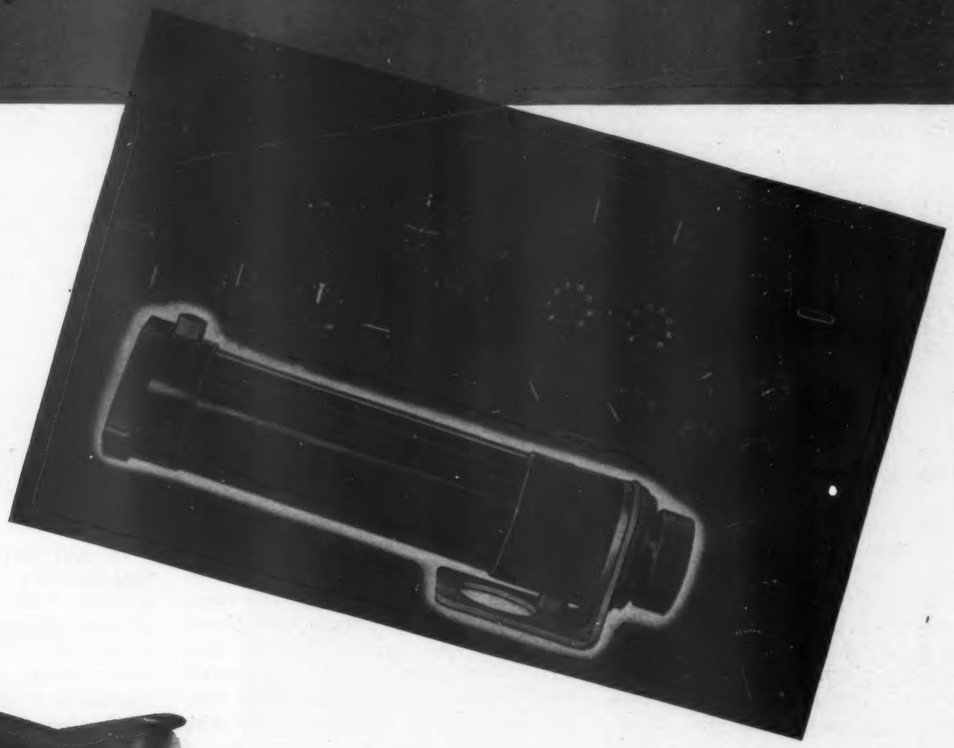
OIL COOLERS INTERCOOLERS CABIN PRESSURE CONTROL SYSTEMS

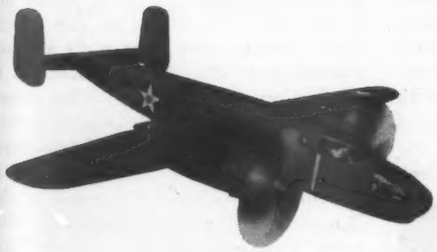
"Teamwork" is the Call to Victory in the Battle of Production



ELECTRONIC BLACK LIGHT

for North American B-25





● **IN ADDITION** to furnishing the aviation industry with Black Light, Vibrator-Type Power Supplies, Control Boxes, and Lamp Assemblies for both *visible* and *invisible* light . . . Electronic maintains a highly-skilled, resourceful engineering staff working daily with military and civil manufacturers *on their specific electrical engineering problems.*

For further information, address:

● The hard-hitting, versatile North American B-25 medium bomber, that can ably double in the role of twin-engined fighter, is equipped with Electronic Invisible Ultra-Violet (Black Light) instrument illumination . . . as are all other new planes for the U. S. Army Air Corps, U. S. Navy, Royal Air Forces of Great Britain, Netherlands East Indies, and others.

Electronic "Black Light" gives *daylight* instrument visibility at *night* . . . without glare or objectionable contrast between inside and outside of pilot's compartment. Thus, Electronic guards against eye fatigue . . . helps keep pilot efficiency high! The Type X-205 Lamp in the B-25 weighs only 7/10 of a pound and operates on but 6 watts . . . with a minimum of maintenance during its long service life.

Electronic "Black Light" is just another example of the way Electronic is solving electrical engineering problems on defense equipment.

ELECTRONIC LABORATORIES, INC.
AIRCRAFT DIVISION, INDIANAPOLIS, INDIANA

North American Aviation

(Continued from page 87)

our production line going while the new supplier is getting set up. And we always have the worry of a parts shortage which may result on some critical item because of spoilage of a production run at some remote plant.

The above potential headaches, plus the constant difficulty of finding and training sufficient executive and supervisory people to make it possible to keep the whole complicated machinery of a major sub-contracting effort in motion, well illustrates the difficulties in the way of accomplishing the requested production miracle.

But in spite of such problems, we have achieved, with the help of all those engaged in this effort, tremendous progress. Our purchases of parts and materials from outside sources will reach a total of more than $100,000,000 for the year 1941, as compared with $45,000,000 in 1940. And percentage-wise we have upped sub-contracting from about 15 percent of our total production early in 1940, to approximately 30 percent on November 1, and with a figure of 34 percent of total production anticipated shortly. It should be emphasized that 34 percent of our total production actually represents a very much greater proportion of possible sub-contracting, since something like half of our total work must be done in the primary plant.

Our production team now has grown to such huge proportions that it includes 65 major sub-contractors and more than 900 suppliers of parts and materials with their plants spread throughout every one of the 48 states. These plants all feed parts and supplies to our three factories located in Inglewood, Calif.; Dallas, Texas; and Kansas City, Kansas. While all subcontracting is supervised from our parent organization in Inglewood, we have found it necessary to establish a subcontract administration office at Cleveland, Ohio. This office facilitates the work of developing and controlling subcontracting throughout the Eastern half of the United States.

In developing this great sub-contracting effort North American Aviation has had the fullest encouragement and cooperation from the government, and especially from the OPM, which has actively fostered the sub-contracting procedure. Other industries, notably the automobile industry, have played a major part in making possible the great progress which has already occurred. While Ford, Chrysler and other manufacturers have worked with other branches of the aviation industry in this connection, it has been our good fortune to have had the close cooperation of the General Motors Corporation. This has made it possible to take advantage of the established administrative procedure and executive and supervisory personnel which operates an integrated nation-wide industrial empire. Through the assistance of the General Motors Corporation many of the problems of finding suitable plants for manufacturing specific parts of our planes have been eliminated. Thus we have been able to work through one central administrative office and through it contact and maintain efficient relations with hundreds of small industrial units of all types scattered throughout the entire country. This advantageous relationship will continue throughout the period of the emergency and will work to the mutual advantage of our own company, the General Motors group, and the entire nation which needs this expanded production of vital weapons.

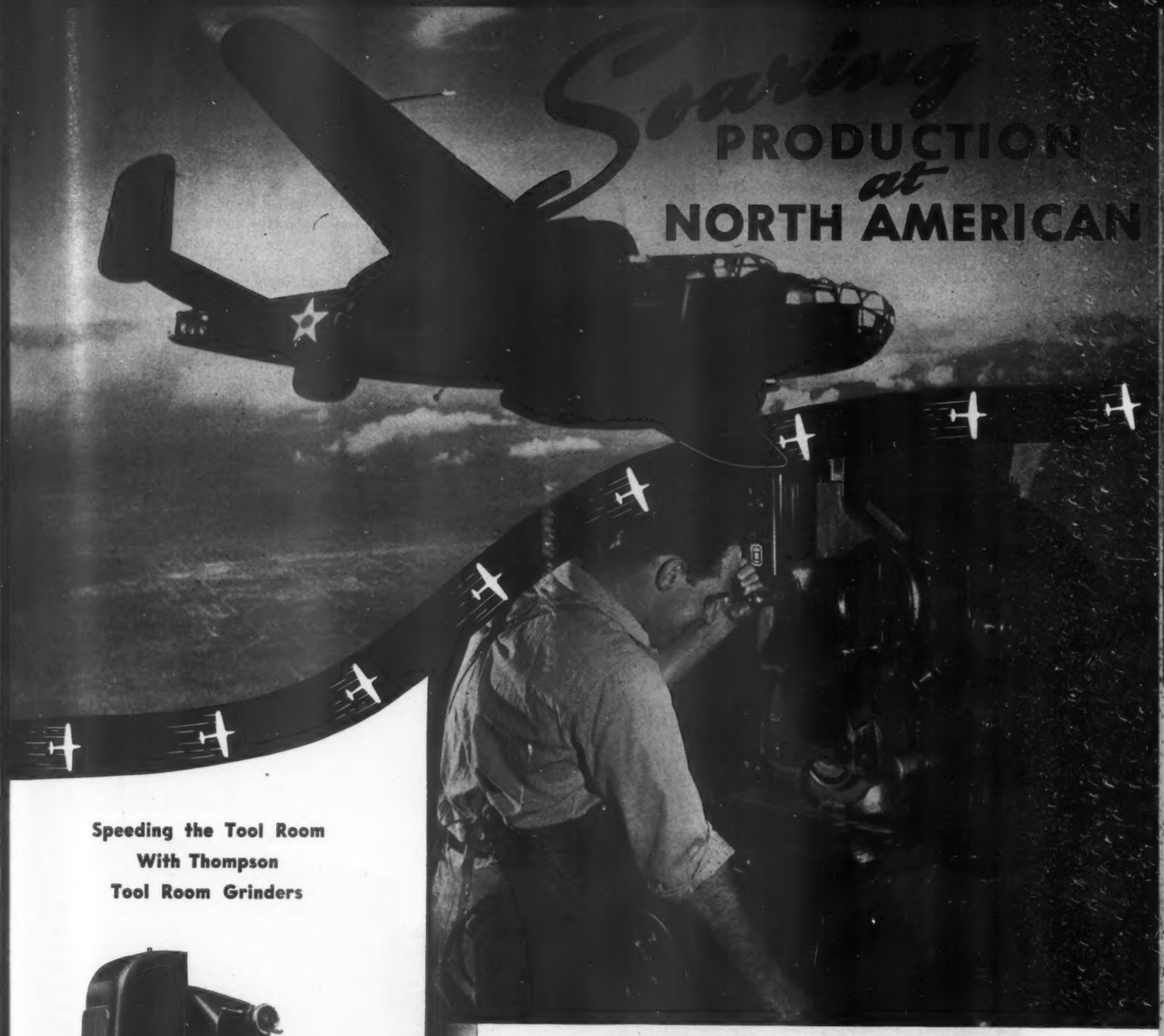
Another phase of sub-contracting which we are developing to advantage is connected with the manufacture of replacement parts for older models of aircraft now in service. We can turn over jigs and fixtures to plants which are able to manufacture such replacement parts efficiently. By careful supervision we are able to assure the customer, whether it be the Army Air Corps, or the air service of Peru, Argentina, or China, that replacement parts will be supplied to meet original specifications. Yet our parent plant will be freed of the necessity of conducting such small scale manufacturing, which would interfere materially with our mass-production effort on modern military planes now needed for actual combat work.

We have been particularly fortunate in connection with the sub-contracting scheme in that our plant was one of the first to break down an airplane for production into the maximum number of sub-assemblies and component parts. We pioneered in spreading the subassembly work back through the shop, doing as little work as possible on the final assembly line. The system proved to have many advantages. But the greatest advantage of all is found now in the ease with which we can allocate these various component parts and subassemblies to outside manufacturers for fabrication and assembly. Our experience with assembly problems over a period of years has helped to discover in advance and eliminate many of the difficulties which arise when a product is assembled from sub-assemblies which were manufactured in various plants remotely located with respect to the final assembly plant.

The detailed procedure which we have worked out for placing sub-contracts and for administering the net-work of plants and suppliers who cooperate with us on the over-all sub-contract effort is too involved for a complete explanation in the space available here. But it may be of interest to sketch an outline how we go about sub-contracting our work.

Specifications and drawings are developed in the engineering department, which works closely with the shop. Engineering personnel has in mind the problems of sub-contracting in the course of preparing the original design and does what it can to develop the design so that it will lend itself to outside fabrication if necessary.

This jig contains the horizontal stabilizer for North American's B-25 which will be subcontracted when production is under way in Kansas City.



Speeding the Tool Room With Thompson Tool Room Grinders

And for your tool room Thompson recently introduced a 6"x18" high speed Surface Grinder streamlined for production, highly sensitive and extremely accurate—capable of working to limits of less than .0001". For production schedules or extremely accurate tool room work, this Thompson Type F Grinder meets the demand for speed and more speed.

with THOMPSON *Grinders*

In the North American Plant as in many other airplane plants, Thompson Grinders are meeting the demands for speedy output, absolute dependability and ease of operation.

It is under the stress of conditions like the present that the true value and full advantages of Thompson Grinders are fully appreciated.

Husky . . . versatile . . . fast . . . Thompson Grinders are a material aid at North American in the grinding to close tolerances a wide range of vital airplane parts, quickly, efficiently, at low cost.

Specifications, bulletins and general production information will be gladly sent upon request.

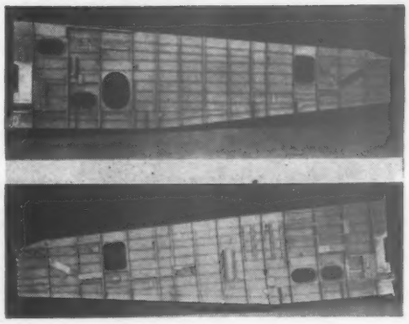
THE Thompson GRINDER CO.
SPRINGFIELD, OHIO

North American Aviation

(*Continued from page 96*)

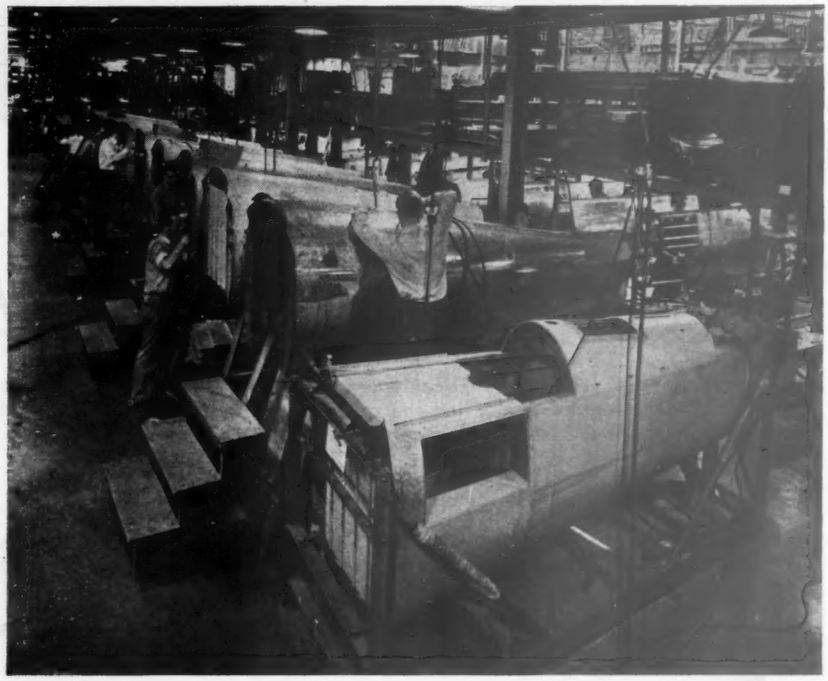
The production department determines what proportion of total work is to be sub-contracted. This is based on a study of the man-hour machinery load curve for the departments concerned. All production requirements above the capacity of the department concerned must obviously be sub-contracted. Which specific parts are to be sub-contracted is then determined on the basis of tooling, nature of the work, etc.

An outside production department maintains a continuing study of outside production facilities available, capacities of such plants and ability of the various shops to handle the required work. Among the considerations entering into this determination are: suitability of machinery; ability to meet required delivery dates; ability to meet quality standards; general considerations of business responsibility and reliability. All of these factors are determined by a staff of field men who maintain constant personal contact with such plants. This staff has multiplied 15 fold in little more than a year. These men are specially trained for such work and often must educate small shops to the standards required in the work to be placed. They frequently find themselves serving as advisers on varied problems of management, machine efficiency, material conservation, and shipping.



Fuselage side panels for the B-25 which may also be fabricated by outside factories and delivered to the main assembly plant.

Following placing of contracts, the sub-contract work is supervised by a follow-up department which investigates production schedules to make sure that work is delivered within the required time. Inspection is handled by a separate outside inspection department which, wherever possible, inspects the work before it is shipped from the sub-contractor's plant. Where this is not practicable a separate inspection is performed at the time of receiving at the primary plant. The receiving department maintains a reporting system which keeps the follow-up and outside production departments informed at all times of the parts or materials placed in the stockroom.



Sub-assembly work on a line of fuselage rear sections. This work is now being sub-contracted.

Through the follow-up and production control departments a constant check is maintained on location and progress of all parts and materials. This makes it possible to shift parts and materials among the three plants, if necessary, and also to give help to the individual sub-contractor, when needed. Such help may consist of furnishing extra material, helping the sub-contractor obtain priorities, furnishing machine tools, or supplying additional blue prints.

The central follow-up department also works in close collaboration with the outside production department to supply tips on prospective plants where work might be farmed out, or to advise against the use of certain shops which may already be overloaded. The follow-up men must have considerable experience and be carefully trained. It is preferred that such men have experience in the company's planning, material control, and production control departments if possible. They must also be well acquainted with the design, construction and detailed parts of the three principal North American production models, the B-25 bomber, the P-51 pursuit, and the AT-6A advanced trainer. These follow-up men must be aggressive in order to keep the wheels turning, but they must be patient and tactful in order to avoid friction.

Work of Investigators

The job of the investigators, who report on prospective sub-contractors is somewhat different but no less exacting. Such investigators must know as much about shop equipment as a seasoned machinist. Men are preferred who have had experience in the shipping and receiving departments. They must know machinery, tools, jigs and fixtures, and must be able to read blueprints. They must also have an intimate knowledge of the company's production models. As mentioned earlier, the number of men now active in connection with our sub-contracting program has grown tremendously. We are expanding this number steadily but it cannot be done over-night due to the special requirements such men must possess.

As with the investigators and follow-up men, the inspectors must have special training and qualifications. The same is true for the personnel in receiving and shipping. Also, a complex cross-indexed bookkeeping system has been developed to keep all departments concerned informed of progress throughout the entire scope of the sub-contract program.

It is a complex and difficult problem, but through teamwork of all concerned we believe we are performing the only production miracle possible at this time.

AAF FILTERS KEEP NORTH AMERICAN PLANTS *Dust* FREE!

American Automatic Filters are comprised of one or more filter sections with rotating filter curtains that automatically clean themselves as they pass through a Viscosine bath at the bottom of the filter. The best features of design and construction of the American Multi-Panel and Double-Duty filters have been combined in the new American Automatic. Complete information on this outstanding filter for ventilating and other industrial uses is available on request. Please ask for Bulletin No. 240D.

American Air Filter equipment cleans the air supplied to work rooms in the huge plants of North American Aviation, Inc., guaranteeing ideal atmospheric working conditions. In the Dallas and Kansas City units alone (J. Gordon Turnbull, Consulting Engineer, Cleveland; Freyn Bros., Heating & Ventilating Contractors, Indianapolis), American Automatics handle 2,500,000 cu. feet of air per minute.

North American is another of the hundreds of companies engaged in defense work which depend upon AAF Dust Control Equipment to keep production moving at unprecedented speed.

American Air Filter engineers have devoted more than 20 years to the study and development of atmospheric and process dust control and are today the world's largest manufacturer of air cleaning equipment.

For *Atmospheric Dusts,* a complete line of filters is offered including fully automatic mechanical and electrostatic types such as are used by North American.

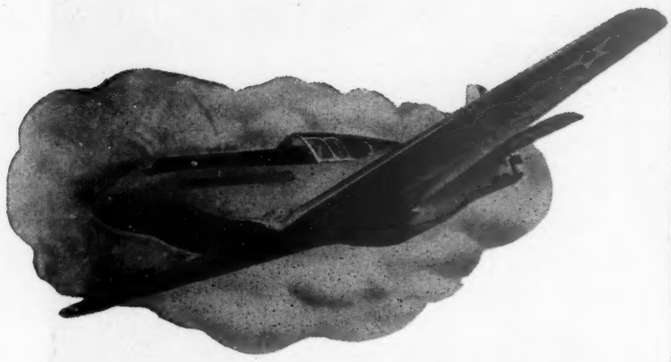
For *Process Dusts,* Roto-Clone collectors—both dry and wet type—are in general use by all industries.

Bulletins describing the application of AAF products are available on request. Write for them.

AMERICAN AIR FILTER COMPANY, INC.
INCORPORATED
308 Central Ave. Louisville, Kentucky

AAF DUST CONTROL *and* AIR FILTRATION EQUIPMENT

"Teamwork" is the Call to Victory
IN THE BATTLE OF PRODUCTION



THE BOSTON AUTO GAGE COMPANY

manufacturer of

DIRECT READING
MAGNETIC
LIQUID LEVEL GAGES

—— is supplying the Aircraft industry with gages for ——

FUEL AND OIL SYSTEMS
HYDRAULIC PROPELLERS
ANTI-ICERS

Illustrated above is North American Aviation's P. 51, built for the U. S. Army Air Corps,—English version, the Mustang. This ship is equipped with two Model 106—NA Boston fuel tank gages.

•

North American's use of Boston products is typical of the team-work between leading aircraft manufacturers and their suppliers of quality equipment.

•

THE BOSTON AUTO GAGE CO., PITTSFIELD, MASSACHUSETTS

STANDAIR

STANDARD AIRCRAFT PRODUCTS
Salutes
NORTH AMERICAN AVIATION

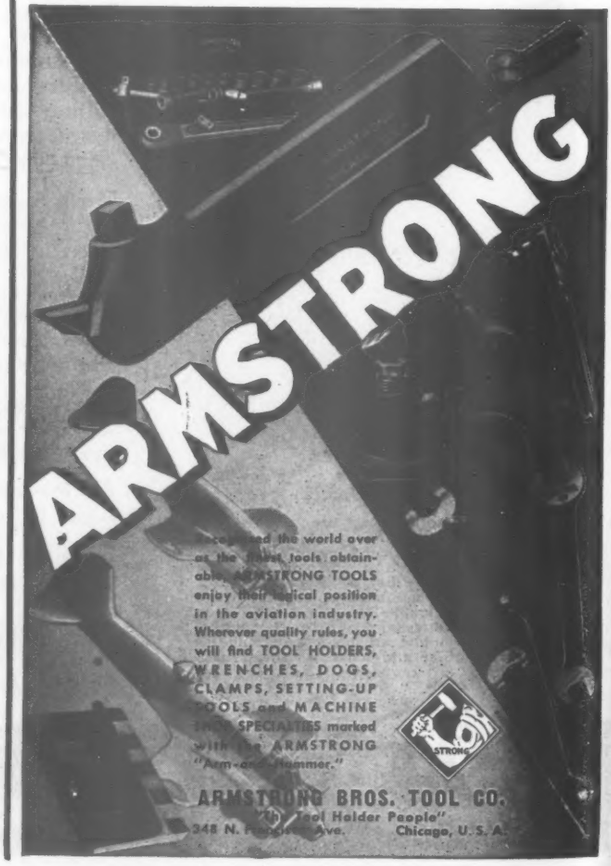
Teamwork is vital! And every component is vital to the perfect, finished product. Standard recognizes its responsibility to the aircraft industry.

"Standard" manufactures:

1. Airplane Lighting Equipment
2. Aircraft Sheet Metal Parts
3. Heat- and Pressure-control Instruments
4. Heat Transfer Equipment

"Teamwork" is the Call to Victory
IN THE BATTLE OF PRODUCTION

STANDARD AIRCRAFT PRODUCTS, INC.
Dayton, Ohio



Streaking through the southern California skies, these North American AT-6A Advanced Trainers, equipped with Wittek Type FB Stainless Steel Hose Clamps, wing toward Army Air Corps Training Bases, where they will be used in the final stage of Cadet training.

Leading aircraft manufacturers, engine builders, and airlines name the Wittek Type FB as the standard specifications hose clamp.

DESIGNED, BUILT AND TESTED

For Aircraft Use

WITTEK

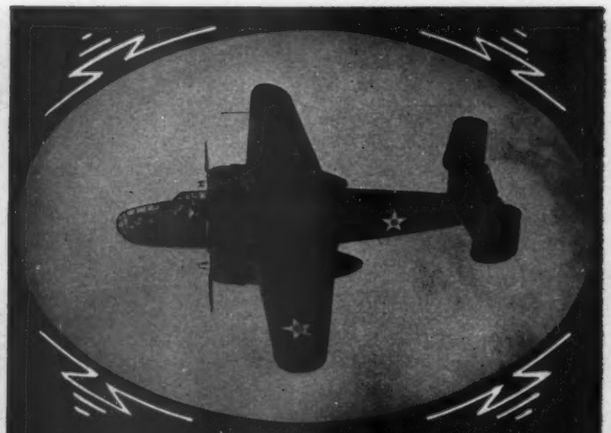
TYPE FB STAINLESS STEEL

HOSE CLAMP

WITTEK

MANUFACTURING CO.

4305 W. 24th Pl., Chicago, Illinois, U.S.A.



NORTH AMERICAN

"Drills the Clouds"

with BUCKEYES

Hundreds of BUCKEYE tools are doing a serious job at NORTH AMERICAN

In an "all out" effort to put American Defense out in front NORTH AMERICAN looks to BUCKEYE tools to put more and more planes in the blue.

Small tools are vital to speedy airplane production, and the extreme flexibility and all around utility of BUCKEYE Tools is a big factor in maintaining the rigid production schedule at NORTH AMERICAN.

Illustrated is a BUCKEYE Shear cutting sheet metal parts easily and quickly at NORTH AMERICAN.

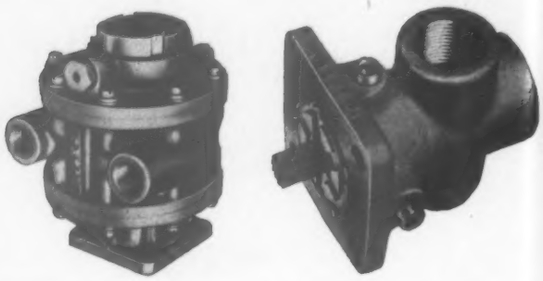
BUCKEYE Tools include:

Drills	Jig Drills	Grinders
Screwdrivers	Countersinks	Angle Drills
Nutrunners	Shears	Corner Drills
	Nibblers	

THE BUCKEYE PORTABLE TOOL CO.

DAYTON • OHIO

ROMEC PUMPS ... ON THE NORTH AMERICAN



"Teamwork" is the Call to Victory
IN THE BATTLE OF PRODUCTION

Romec salutes North American for its achievement and speed in the aircraft program.

Illustrated here are two Romec Pumps used by North American. RD-4120, with fuel pressures ranging from 2 to 25 lbs. per sq. in., with constant flow of 150 G.P.H. Capacity based on pump speed of 1750 r.p.m. Its non-pulsating feature assures dependable performance at greater pressures.

RD-2112 Vacuum Instrument Pump has a free air capacity of 4½ cubic feet per minute at 1500 r.p.m. Designed with self-adjusting rockers containing metallic packing strips locked in the end of the sweeping vanes.

ROMEC PUMP CO. ELYRIA, OHIO

PIONEERS IN THE MANUFACTURE OF A COMPLETE LINE OF AIRCRAFT PUMPS.

FOR FLIGHT *Precision*

Arens is proud to serve the Army by supplying the new B-25's with quality precision remote controls.
In the air, where precision is vital, you'll find the Army's new North American twin-engine, medium bombers equipped with Arens precision remote controls.

Write for Complete Catalog

ARENS CONTROLS, INC.
2257 South Halsted Street, Chicago, Illinois

IT'S UNDER PERFECT CONTROL IF IT'S ARENS

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The "MARKET PLACE" OF AVIATION

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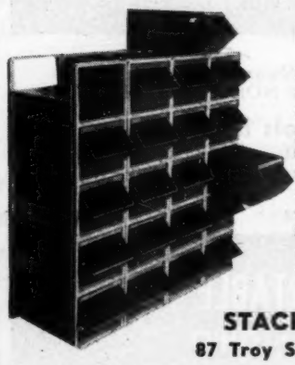

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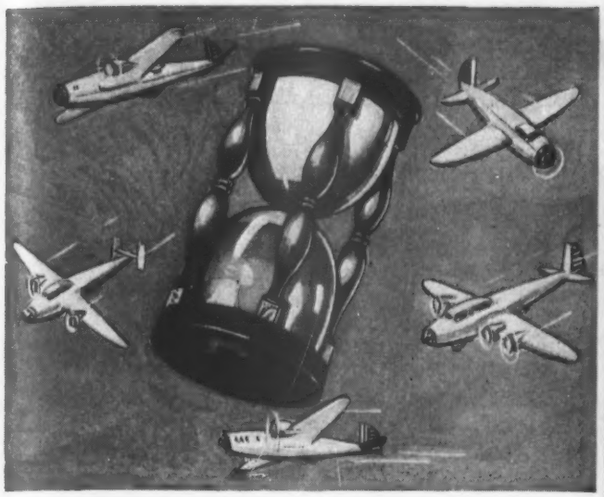

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Britain's New "Heavies"

FOREIGN & EQUIPMENT

The British turn to the long range, heavy bomber, a type pioneered by our Air Corps.—Some comparisons with the Boeing Flying Fortresses.

ENGLAND having come rather abruptly, for reasons best known to the R.A.F., to a more than academic interest in heavy, long range bombers, there is naturally some speculation on this side of the water over the home-grown British models, the Handley Page Halifax and Short Stirling.

As the long range, high altitude, bomber was pioneered in this country, among the questions foremost in American minds is, how do the new British bombers stack up against the Flying Fortress, a type originally developed by the Boeing Airplane Co. for our Air Corps in the early 30-s?

Details released by the Air Ministry on the Halifax and Stirling are confined mainly to physical descriptions; performance figures are kept secret, although a number of Halifaxes have been brought down over enemy territory. The Stirling, which is somewhat the larger of the two, weighing about 65,000 lb. gross, has a wing span of 99 ft., length of 87 ft. 3 in., and a height of 22 ft. 9 in. Fortresses, weighing 47,500 lb. gross and 31,160 lb. empty, have a greater wing span, 103 ft., but overall length is considerably less, approximately 68 ft. So the Stirling, built like a flying box car, must be capable of carrying a bigger bundle of bombs to Berlin, something like 6-7,000 lb. The Fortress Model C carries about 4,800 lb. in bombs.

Power for the Stirling comes from either four Bristol Hercules 14-cylinder air-cooled radials of 1,600 hp. each, or four double-row 1,600 hp. Wright Cyclone 14's. Boeings are powered by Cyclone 9's.

The Halifax is approximately the same size as the Boeings, although it is greater in height by some feet—span is 99 ft., length 70 ft., and height 22 ft.—but unlike any other British or American heavy bombers, it is powered by liquid-cooled engines, four Rolls-Royce Merlins rated at about 1,050 hp. each at 18,500 ft. Both the Halifax and the Stirling are midwing monoplanes, but whereas the former has twin fins and rudders, the Stirling has a single tail structure.

The Halifax is reported to have good controllability. Stalled in a demonstration flight last Sept. 12, the motors are said to have picked up again with little loss of altitude. Take-off was quite short and with the Handley Page slotted flaps fully depressed, landing was said to be both slow and reasonably short.

Three-bladed Rotol constant speed, full feathering propellers are used, and the Merlins are housed in nacelles which are level with the upper surfaces of the wings. Two glycol radiators and an oil cooler are carried together in a duct under the crankcase. Exhausts are single jet, flame damping types.

Of all metal construction, the Halifax is said to have been designed for rapid production, although as both bombers were just being built when the war started it is probable large numbers have not yet been produced. Each part is divided into sections small enough for easy transportation from shadow factories to final assembly points, and each section is in turn sub-divided to obtain maximum economy of man power.

The wings are of sweep-back design with square-cut tips, affording the pilot and bomb-aimer a lateral view extending abaft of the beam. For some reason the wings are not provided with de-icers, although the tail is. The Stirling seems to be similarly equipped.

Landing gear on the Halifax is a remarkably sturdy-looking fork-type, which is a single magnesium casting, having telescopic action capable of more than 12 inches travel. Retraction is backwards into the inboard nacelles. The Halifax's tailwheel is fixed, but the interesting double tailwheel on the Stirling, installed undoubtedly because of the great loads carried, is retractable, as is also the main landing gear.

A flying box car, which probably carries a bigger load of bombs than any other bomber, the Short Stirling has bomb-bay doors extending from beneath the pilots' cockpit almost two-thirds the whole fuselage length of 87 ft.

Press Association

British Combine

The Handley Page Halifax is powered by liquid-cooled Rolls-Royce Merlins. Note the single-orifice exhausts on the engines and fuel jettison pipes below wing flaps. Landing gear is a single magnesium casting.

British Combine

Close-up of the triple racks in which the Stirling's bombs are loaded. Ground crew are attaching a cable by which the 500 lb. bomb is hoisted into the rack by a motor.

British Combine

Fuel and bombs being loaded into a Stirling for a heavy raid on the Ruhr and Rhineland.

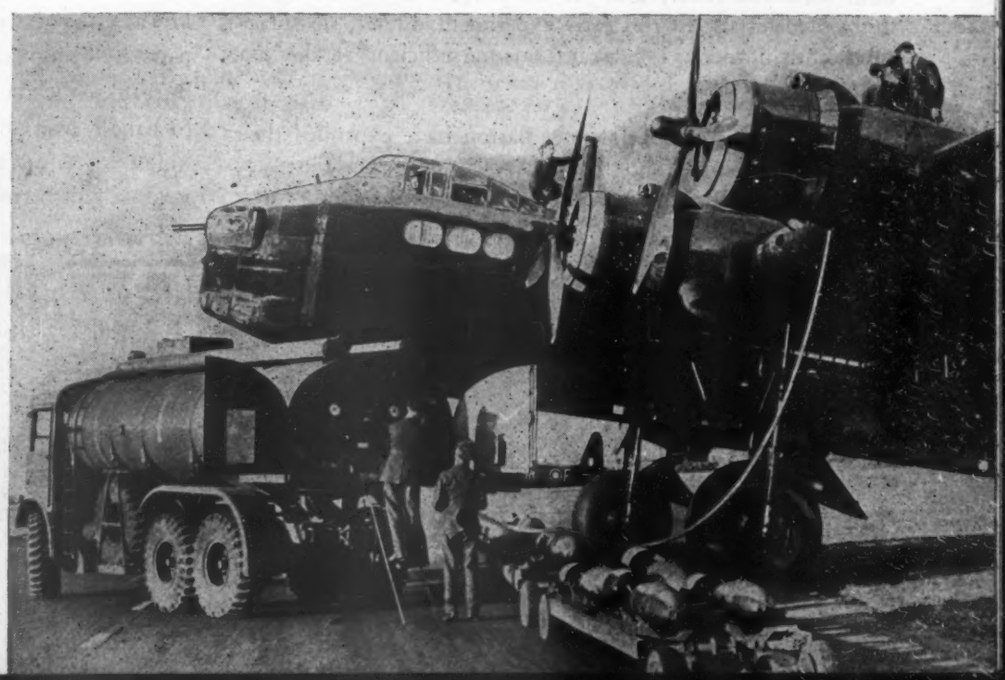
Bomb compartments take up most of the fuselage below the wing in these planes—triple bomb racks extend almost ⅔ the length of the Stirling's 87 ft. fuselage, starting from beneath the pilots' cockpit in the nose—and armament is reported to be very heavy. On the Halifax a 4-gun Boulton Paul power turret is installed in the rear tail position and a 2-gun turret in the nose, which in both bombers, especially the Stirling, juts far out beyond the leading edge of the wings. The Stirling is apparently armed in like manner, with further armaments on either unrevealed. Armament on the Boeing B-17E is also heavy, with a power turret "stinger" in the tail and another in the fuselage, in addition to the belly guns.

Neither the Halifax nor the Stirling were in service until some time after the present dispute with Germany started—it is reported that last winter not more than two squadrons of Stirlings were in operation at any one time. A perhaps significant revelation concerning the Halifax, in lieu of performance figures, is the admission that "several have been lost", whereas up to this time there has been no confirmed loss of a Flying Fortress. Undoubtedly, no Boeings have been lost because they can reach altitudes in excess of effective ground fire, and, although Me 109 F's have engaged the Fortresses in combat at 30,000 ft., the Nazi fighters find it difficult to maneuver at that altitude.

British pilots, not the magazine writers, are credited with saying that at high altitudes the Boeing was definitely better than the Stirling or Halifax, and that at 25,000 ft. they found it to be even faster than the Spitfire or Hurricane.

Thus, any shortcomings in the defensive armament of the Boeings, so often complained of by British aviation journals, is more than made up by their ability to climb far above the effective

(Turn to page 218)



The PROOF OF THE PUDDING

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From a then-astounding record of 600 parts per month in 1935, they have advanced the art until now over 100,000 parts are being examined monthly. Facilities now installed in Burbank, Wichita and elsewhere will enable Triplett & Barton to handle over 500,000 parts per month when the aviation industry has advanced to the point where this tremendous volume will be required.

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Morrow Plywood Trainer

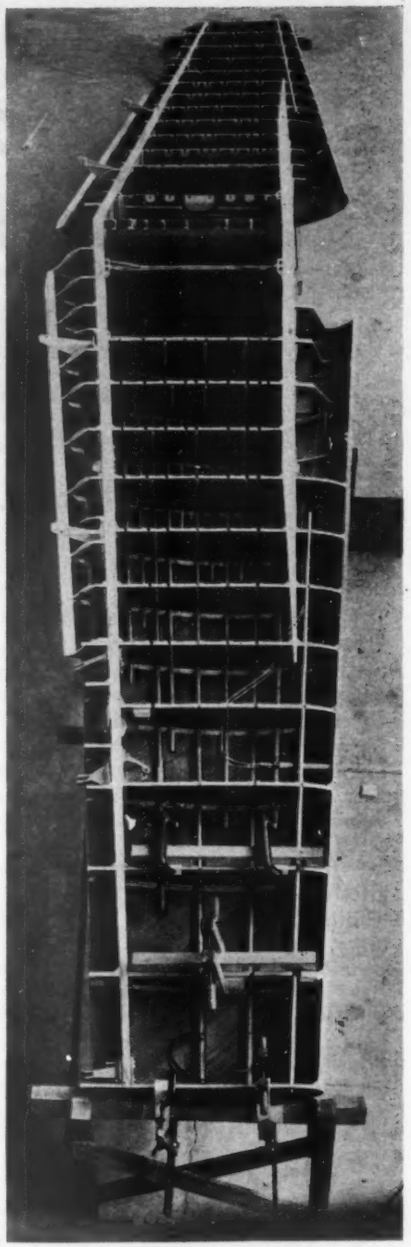
LATEST plastic bonded plywood training plane is the Morrow Victory secondary trainer test flown Nov. 1, in San Bernardino, Calif., by Vance Breese. Powered with the new 175 hp. horizontally opposed six-cylinder Lycoming engine, this tandem training plane has a top speed of 165 m.p.h. General design is conventional, of low wing cantilever monoplane arrangement with retractable landing gear. Unusual performance is claimed to result from the smooth surface provided by the plywood which is bonded and impregnated with a plastic resin.

Said to be built of materials that are plentiful on the Pacific Coast, the structure is of wood throughout, except for such parts as engine mount and landing gear, and has been designed to take the fullest advantage of plastic bonded wood material. Fuselage framework is of laminated bulkhead rings, with longitudinal spruce stringers, over which inner and outer molded skin sections are attached in two halves. The wing is built in one piece, bolted directly to the fuselage. A novel structural feature is that, while the rear spar runs for the full span of the wing, serving as an attachment for the flaps and airlerons, the front spar does not extend much beyond the landing gear support point.

The retractable landing gear is hydraulically actuated by means of a hand pump. Brakes are hydraulic, a special feature being a hydraulic brake lock which acts as a parking brake.

Wing span of the Victory trainer is 30 ft. 4 in., overall length 25 ft. 4 in., height 7 ft. 9 in. and weight empty 1656 lb. Range is 1,000 mi., top speed 165 m.p.h., cruising speed 145 m.p.h., and landing speed with flaps 55 m.p.h. Standard equipment includes hydraulically operated retractable landing gear, oleo shock struts, hydraulic brakes, hydraulically operated split flaps, complete Kollsman flight instruments on shock-mounted instrument panels in both cockpits, adjustable rudder pedals, Ranger radio receiver and transmitter in rear cockpit only, and hand fire-extinguisher.

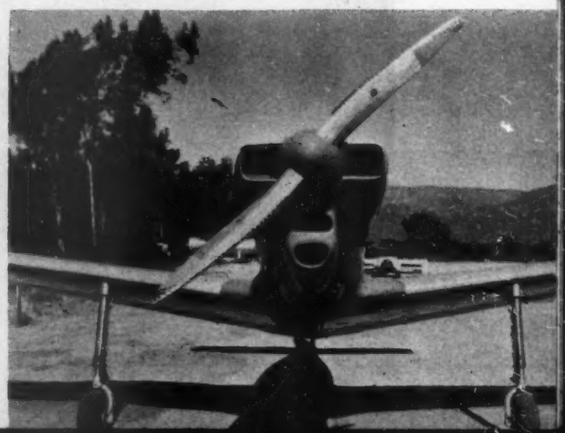
A new-comer among California aircraft companies, Morrow Aircraft Corp. was formed in 1940 by Howard and Frank Morrow, successful eastern merchants. Associated with the Morrow brothers is W. R. Angell, Jr., formerly in charge of the aeronautical division of Continental Motors Corp. Chief Engineer is Dwight S. Mills, formerly with Lockheed Aircraft Corp.



Above, the under side of the half-completed, full cantilever wing of the Morrow trainer, showing self-sealing integral fuel tanks on either side of fuselage attachment point.

Each half of the fuselage sk'n is molded to the shape of fuselage to which it is bonded with a plastic resin.

Landing gear of the trainer is hydraulically operated and retracts into wells toward fuselage center.



Laboratory Control For Ranger Engines

Extensive Laboratory control of materials and methods makes for constant improvement in quality and performance of Ranger Aircraft Engines.

By Clinton B. F. Macauley, *Washington Editor, Aviation*

WE can all remember when a machine shop or engine factory was an honest, reliable-looking structure of dingy aspect with grimy windows and myriad overhead pulleys with long belts slapping in the breeze. Stubble-faced machinists in greasy overalls hunched over their machines hour after hour, unmindful of the litter of waste and scrap in which they stood.

Certain old-timers, whose sentimental affections for a past now dead tend to belittle the achievements of a newer order, have been heard to snort in their beer in disgust at the bright and cheerful aspect of clean plants with air conditioning and miles of fluorescent lighting tubes, stubbornly refusing to face the facts of their improved efficiency of production and the superior quality of the products manufactured.

Labs Move Into Factories

To these old-timers a "laboratory" was a vague place up at the State University where every now and then a piece of this or that was sent for analysis or testing. Today the laboratory has moved right into the factory. If it isn't in the plant itself, it's right next door. And this is as it should be, for out of the laboratories come the new ideas, techniques and products which will enable the industry to meet successfully the inevitable readjustments of post-war years.

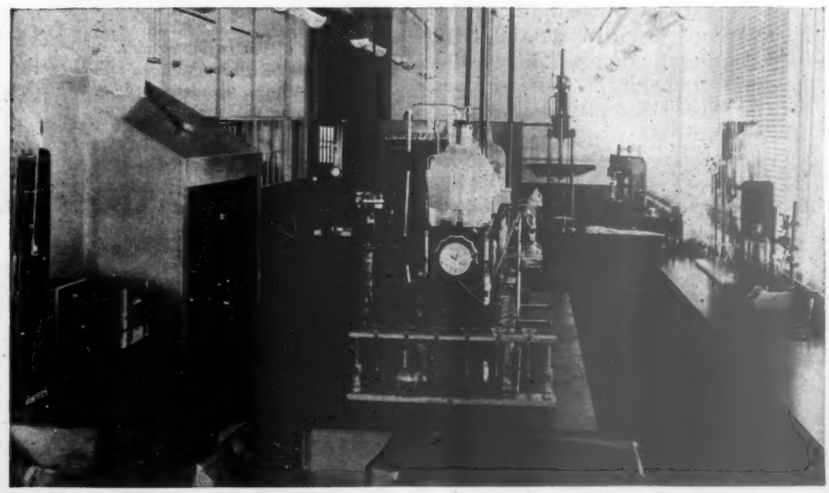
The well-equipped metallurgical laboratories in the Ranger Aircraft Engines plant at Farmingdale, Long Island, provide an excellent example of how mechanic and scientist now are working side by side to the end that a particular engine will be as fine as human knowledge, ingenuity and patience can make it. In the present emergency, national defense producers also are fighting against time. The efficient utilization of newest laboratory techniques in close coordination with production processes frequently saves days and weeks in critical instances, and in the long run doubtless gains months and years over older methods in the improvement of design, materials and performance.

The personnel of the metallurgical department at Ranger consists of a group of analytical engineers, each highly specialized in his particular field, engaged in spectrographic analysis, photoelastic analysis, chemical analysis, physical testing, microscopic study, and development work in the fields of heat-treating and casting.

Function of the Laboratory

This is how the laboratory functions. Suppose a cylinder-barrel forging isn't machining-up properly in the shop, or for some other reason is under suspicion —despite the fact that chemical analysis and physical test reports are required for all Ranger materials. A new complete chemical analysis might require up to a week. Obviously impractical, but aircraft engine manufacturers cannot fool with questionable materials. So drillings or chips from the forging are sent in for a spectrographic analysis. In about half an hour the presence or absence of all of about 70 different elements will have been determined, and for many of these elements the percentage of each will be known, more accurately than is feasible by any other method.

Or, suppose a tiny speck of matter is found in a bearing surface and it is important to know what it is. Chemical



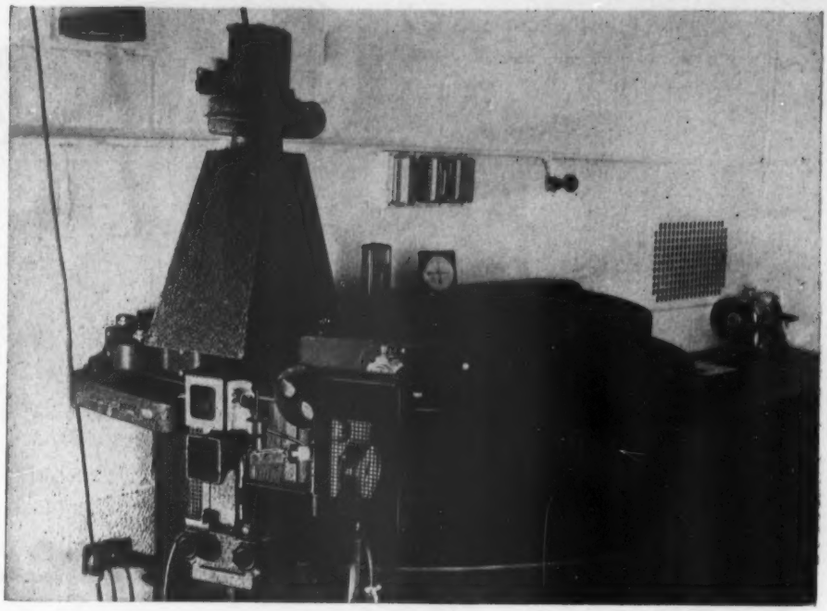
The well equipped chemical laboratory in Ranger's metallurgical department.

Photographic film of spectrographic analyses. Each film strip accommodates up to eight spectrographs. The presence of dark vertical lines indicates the existence of elements whose wave-lengths appear in that portion of the spectrum.

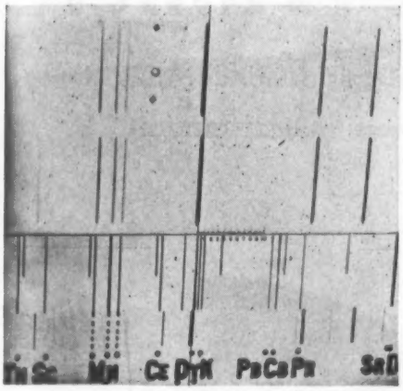
analysis would be impossible with so little material to work on. But a veritable pin point of matter can be made to reveal its composition under spectrographic analysis.

Photographing the Elements

By this method the samples to be analyzed form the electrodes for a powerful spark. Ultra-violet rays emitted by the spark are broken down by the grating to form an evenly graded segment of the spectrum. This is recorded on photographic film which is quickly developed and dried, providing a permanent record of the analysis. The film is projected onto a screen and synchronized with a master scale paralleling it. Visible lines on the sample spectrum indicate the presence of a particular element. The wave length of each line, determined by its location on the scale, accurately reveals the identity of all of the elements present in the sample. Densitometer readings of these lines are obtained automatically through a micro slit and a photoelectric cell, all by simply pushing a button after adjusting the desired line to the control location. This reading is used in conjunction with calibration charts to give directly the percentage of the element which the sample contains.



The basic unit of equipment of the spectrographic laboratory. Material to be analyzed forms the electrodes for a high-voltage arc. Ultra-violet rays from the spark are broken down to provide a portion of the spectrum which can be photographed, revealing the composition of the material and providing a permanent record for study and comparison.



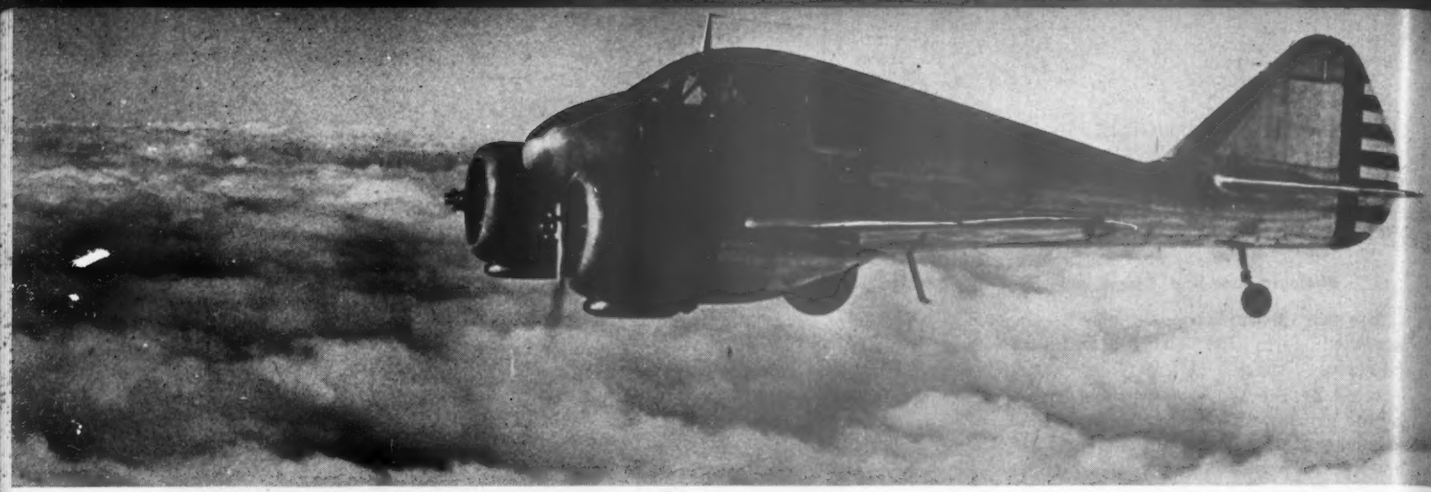
A sample spectrograph is projected onto a screen and synchronized with a master scale paralleling it. The spectrum lines of the various elements are identified on the master scale.

The presence of any element can be detected by spectrographic analysis. However, the amount of carbon, phosphorus, and sulphur in steel still must be tracked down in the chemical lab, but special chemical apparatus makes it possible to find the amount of carbon and sulphur in steel within a few minutes. The detection of phosphorus requires somewhat longer time. The chemical laboratory of course is well equipped to make complete chemical analyses by conventional quantitative methods, as a periodic check on the accuracy of the elaborate spectrographic equipment. For small percentages of alloying elements, the spectrograph offers greater accuracy, less opportunity for errors, and vastly greater speed. In order to insure these results all of the spectrographic equipment has been located in three connecting rooms which are air-conditioned by a separate unit, to maintain dust-free conditions and constant temperature and humidity. The conditioned air is kept under pressure, so that leakage will always be out from the spectrographic laboratory and dust cannot enter.

The chemical laboratory in addition to the previously mentioned work, also checks the composition of cadmium and copper plating solutions, etching solutions, cleaning baths and various other

(Turn to page 190)

Illustrating the photoelastic method is this photograph with circularly polarized light of a Marblette model of an engine part under load.



New Twin-Engined Trainer

Curtiss AT-9 incorporates same general performance and operating characteristics as multi-engined tactical aircraft

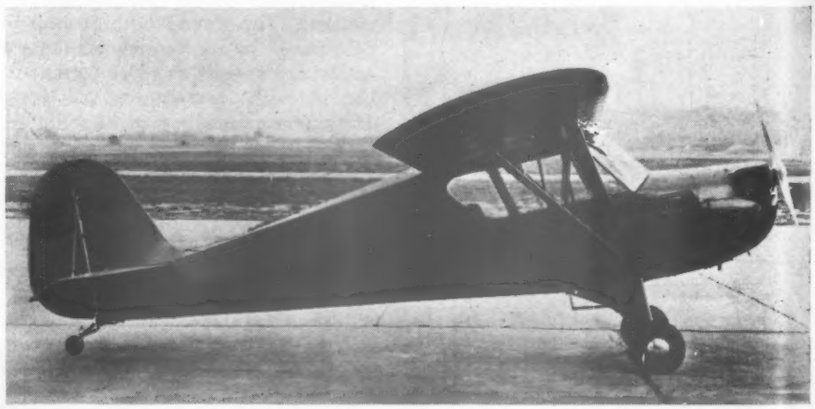
A NEW type of twin-engined plane for high speed, multi-engined fighter and bomber training was announced recently by Curtiss-Wright Corp. through Guy W. Vaughan, president of the firm. Delivery of the first plane to the Army Air Forces for accelerated service tests has been made.

Called the Curtiss AT-9, the new twin-engined plane was designed to shorten the long difficult step which young Army pilots experience in transferring from the single-engined, low powered training plane to the latest types of multi-engined tactical craft. It therefore incorporates the same general performance and operating characteristics of the latter types, including numerous instruments.

An all metal, low wing monoplane, it is equipped with retractable landing gear of the conventional type and has two side by side seats with provisions for two additional seats immediately aft of the two pilots. Power is supplied by two 280 hp. radials and fuel capacity is 150 gal. Many features have been incorporated in accordance with specific training demands of the Air Forces.

Top speed is more than 200 m.p.h. and range is 750 miles. Developed by the St. Louis, Mo., plant of the Curtiss-Wright Airplane Div., it is ideally adapted to mass production, according to Mr. Vaughan. A large number of them will be produced in the new Curtiss-Wright Airplane factory at Lambert Field in St. Louis.

The plane is said to be undergoing tests during which it is being flown as many hours within a few weeks as it would normally operate under ordinary service conditions in a year or more.



Aeronca Defender

THE Aeronca Defender, a new tandem trainer, is now in production by Aeronca Aircraft Corp., Middletown, Ohio.

Engineered for a 65 hp. motor, the plane now has for standard equipment an improved type of muffler. Engine cowling has been modified and strengthened around the base of the windshield. This new installation was conceived, it is said, for the remarkable effect it has in reducing engine noises in the cabin.

Extra heavy verticle tubes have been installed on each side of the cabin, eliminating a diagonal cluster and, as a result, materially strengthening the entire side of the fuselage. Exceedingly rough landings will now transfer shock through the gear and up through this tube and expand itself through the various connecting members. Addition of this oversize tube will insure complete fuselage protection against bad "stall outs" in landings, it is claimed.

Leverages on all control surfaces have been changed and approximately 1½ sq. ft. area has been taken off the rudder. The reduced rudder has been balanced, thus providing a control surface that is said to be exceptionally light to operate. Aileron chord has been decreased and is now of the slotted semi-frise type. Control is by means of a differential. Ele-

(*Turn to page 202*)

Flying EQUIPMENT

(Official photograph, courtesy United States Navy)

It may seem a far cry from a coal mine or a coke plant to one of these Navy SBC-4 dive bombers, and the aviation industry, but the connection is pretty close in many things.

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At either side of the divider, in the above picture, are new VARD external comparators small handy table instruments, for checking limits in manufacturing. One is a dial gauge type. The other is a liquid column reading type. Both quickly indicate variations as small as one ten-thousandth of an inch. Each can handle work quickly. Adjustments are simple and positive.

VARD builds precision gages for checking threads, holes, and thickness. Likewise we produce special taps, optical lenses, prisms, and mirrors. Another branch of our organization turns out aircraft hydraulic units, drafting, and navigating instruments.

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VARD MECHANICAL LABORATORY

S. A. E. Engineers Review Year of Greatest Production Progress

Los Angeles meeting sums up achievements of past 12 months.

Photos by C. F. McReynolds, AVIATION'S Pacific Coast Editor.

NOW a traditional event among aviation engineers, the 1941 Annual Aircraft Production Meeting sponsored by the Society of Automotive Engineers in the Biltmore Hotel, Los Angeles, fully equalled previous such meetings in interest, attendance, and value to our production effort. Through Oct. 30, 31, and Nov. 1, engineers and industry executives crowded the sessions and the accompanying engineering display in the foyer adjoining the main auditorium. It is a convincing demonstration of the vitality of democratic traditions and principles that men can be found to join in staging such a successful meeting at a time when we are straining every nerve to meet production schedules. Not only had busy engineers taken time out to prepare and present important reports on significant developments, but there was no lack for an audience. As in the past the hall was several times jammed to complete capacity and there was every evidence that this year those in attendance were even more seriously interested in the proceedings than ever before. Total registration was approximately 1000 but there were a great many more who attended but did not register. Total attendance at the various sessions of the three-day meeting exceeded three thousand people, not counting those who inspected the engineering exhibit. Nor would it be fair to judge the success of this meeting by the number of those in attendance for many of the industry's top notables were there, including F. C. Crawford, of Thompson Products; T. P. Wright, OPM; Robert Hinckley, Asst. Secty. of Commerce, and A. T. Colwell, to mention only a very few.

Keynote of the meeting was struck by T. P. Wright with an address on morale. His encouraging report of our production progress during the past year gave sound reasons why we should have confidence in our weapons, our leaders, and ourselves. Along this same line was the report on "Blitzkrieg and How to Stop It," by A. T. Colwell, S.A.E. president. Colwell's analysis of military developments of the present war left little doubt that an all-out production effort was the principal solution to our problem of stopping the Blitzkrieg.

But not all of the discussion was on military developments. One of the biggest crowds of the meeting gathered to hear Wm. B. Stout tell about his new light airplane and engine, which are being developed with an eye on the "after-the-war" market.

On the production side there were invaluable reports of such new developments as the duPont explosive rivet, George Tharratt's description of the use of perspective sketches in place of blueprints on the final production line, the place standardization is playing in our expanded production effort, by C. E. Stryker, of the OPM, etc.

Research reports were concentrated largely on problems of high altitude operation, including two-speed superchargers, air intake scoop research, icing problems, and vapor lock investigation. Importance of this work was stressed by F. C. Crawford, pres. of Thompson Products, in stating that many experts believed that whichever side succeeded best in solving problems of high altitude flight would win the war.

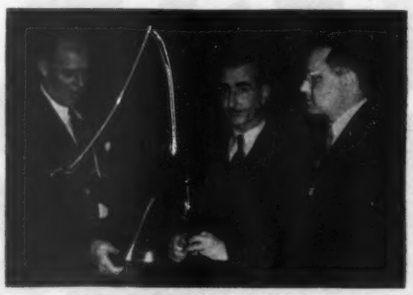
Exhibits in the Engineering Display quite properly featured the part subcontractors and vendors are playing in the amazing expansion of aircraft pro-

(*Turn to page* 168)

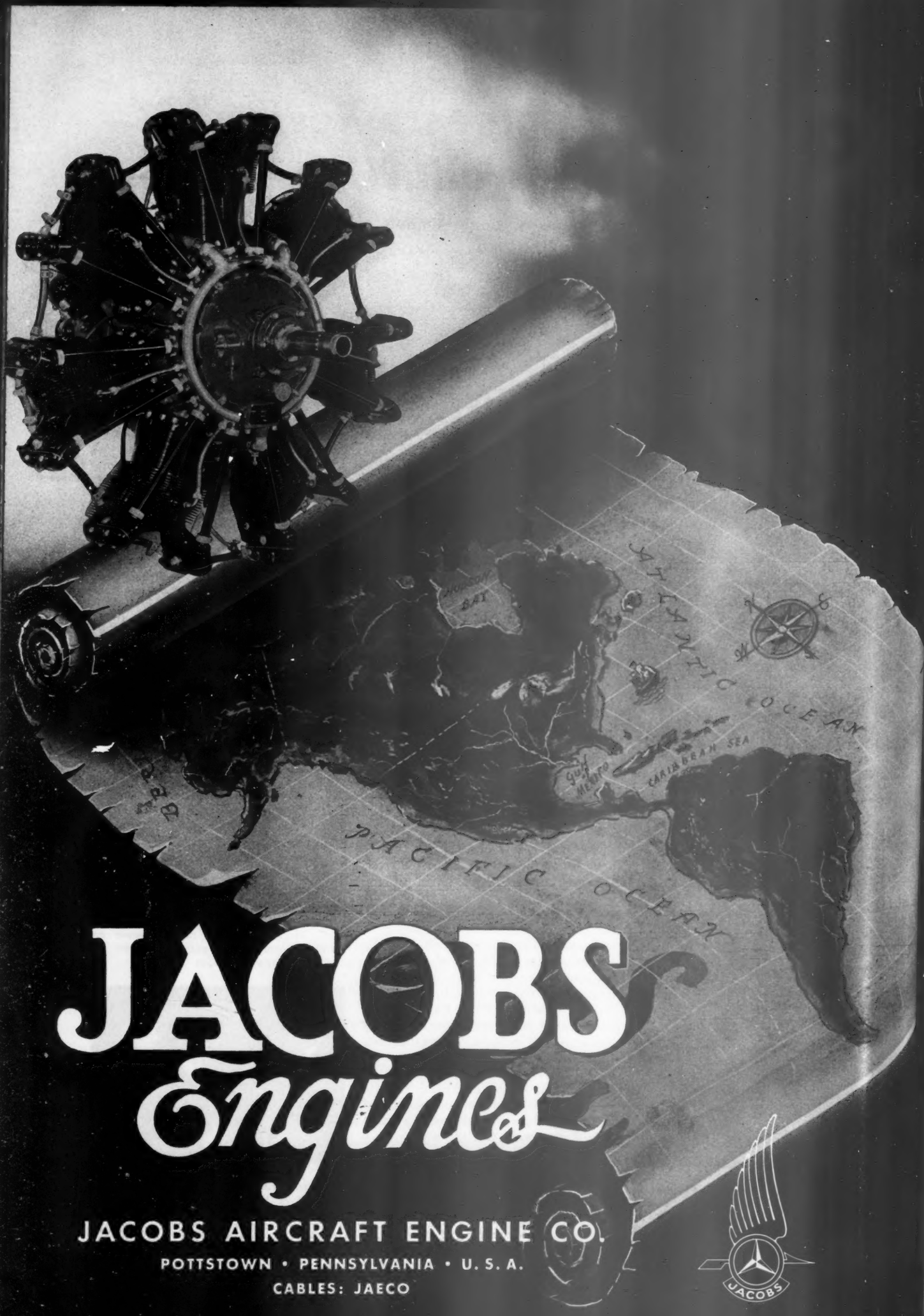
Peter Rossmann, left, of Curtiss-Wright in Buffalo, and T. P. Wright, who gave one of the principal talks of the meetings.

Bill Stout proved to be one of the chief spellbinders when he described his new airplane and engine.

F. C. Mock, of Bendix, read a paper on carburetor air scoops and their effect on fuel-air metering in flight.



L to r: Carleton Stryker of OPM; George Tharratt of both Douglas and Adel; and Mac Short of Vega.



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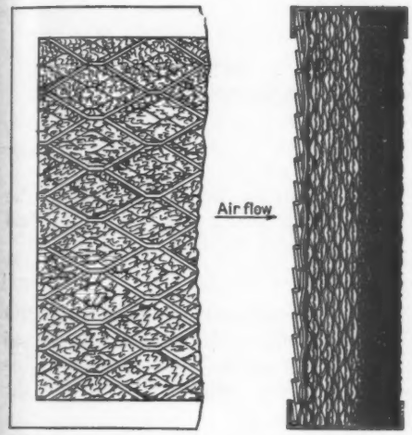
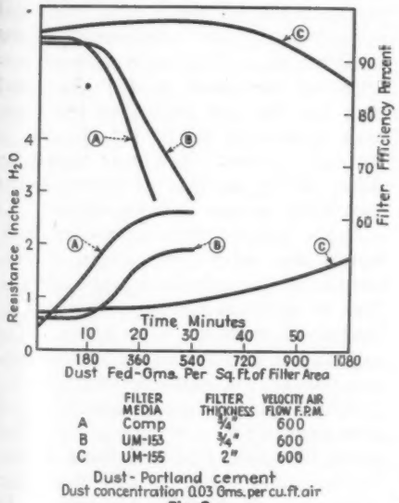
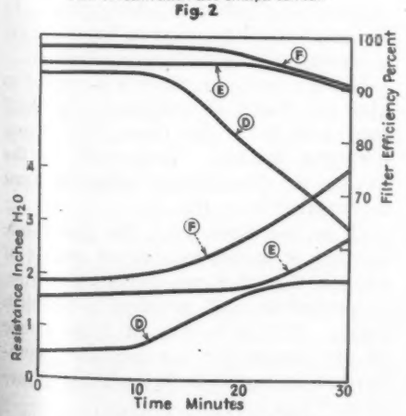


Fig. 1
UM-155



	FILTER MEDIA	FILTER THICKNESS	VELOCITY AIR FLOW F.P.M.
A	Comp	¾"	600
B	UM-153	¾"	600
C	UM-155	2"	600

Dust - Portland cement
Dust concentration 0.03 Gms. per cu. ft. air
Fig. 2



	FILTER MEDIA	FILTER THICKNESS	VELOCITY AIR FLOW F.P.M.
D	UM-153	¾"	600
E	UM-152	2"	900
F	UM-155	2"	1000

Dust-Portland cement
Dust concentration 0.03 Gms. per cu. ft. air
Fig. 3

This article is of timely interest because of recent emphasis on air filters for all military airplanes.

By Wm. K. Gregory, *Division Manager, American Air Filter Co., Inc.*

Preliminary research covering air filters for the protection of airplane engines was covered by an article which appeared in the October issue of "AVIATION". Further research has continued, and in collaboration with the Army, Navy, individual airplane manufacturers and motor manufacturers, it has been possible to establish definite air filter specifications and a standardized test procedure which differs from the test procedure previously followed and reported in the earlier article.

PLANS are being made at the present time to install intake air filters on the motors of virtually all training planes, bombers and fighters now being manufactured for the U. S. government. The experience of the British in their operations in the deserts of Africa and elsewhere has emphasized the importance of air filter protection.

Even in the United States severe engine wear has occurred at a number of air fields, particularly those in the South. When our air activities were limited to commercial planes and a relatively small number of Army and Navy planes which used well-paved runways, we had no acute dust problem, but with our expanding air force it has become necessary to use more and more temporary air ports with unpaved runways. Planes taking off in formation generally use some of the unpaved portion of the field even where paved runways are available, and great clouds of dust are kicked up by the planes in the lead which go into the engines of the planes following unless adequate air filter protection is provided. This obviously results in excessive engine wear and makes it necessary to overhaul and rebuild engines at frequent intervals, thus increasing the amount of maintenance required. Disregarding the expense of this maintenance, we are now confronted with a problem of production, and anything which can be done to increase the effective life of an airplane motor is virtually equivalent to increasing our production facilities.

The first step in the application of air filters to airplane engines is the selection of the type of filter to be used. Oil bath air cleaners, which have been used with great success on trucks, tractors and large stationary Diesel and gas engines, are ruled out immediately due to their size, weight and the fact that oil would spill out in maneuvering the plane. Dry type air filters, which employ felt or other fabric as a filter media, are inflammable and require frequent replacement. During actual warfare, the replacement of dry type filters would constitute a serious problem, as it would be necessary to provide cargo space for shipment and a dry place for storage. Another objection to dry type filters is that they offer a high resistance to air flow and increase rapidly in resistance as dust is accumulated. For all these reasons, dry type filters are considered unsuitable for airplane application even though some of them have been used with certain success by the British.

If the oil bath and dry type filters are eliminated from consideration this leaves only the washable viscous impingement type filter. Air filters of this type consist of a metallic filter media mounted in channel frames and so arranged as to provide a tortuous path for the air passing through. This filter media is coated with oil, and when dust carried in the air stream strikes the oil-coated surfaces it is caught and held. A typical filter of this type, which is so designed that there is a considerable amount of space between the individual strands of filter media on the air-entering side and the density gradually increases toward the air-leaving side, is shown in Fig. 1. The purpose of this construction, which is normally referred to as "progressive packing", is to distribute the dust caught

(*Turn to page 206*)

Presented at the October meeting of the American Society of Mechanical Engineers at Louisville, Ky.

A Procedure Control For Aircraft Welding

By A. K. Seemann, *Engineer,* *The Linde Air Products Company*

Part II

Part I of this article, published in the November, 1941 issue, discussed the need for a procedure control, problems of engineering design for welding, selection and inspection of materials and such factors in procedure as edge preparation, spacing, penetration, reinforcement and rods.

TO make an oxy-acetylene weld, a small area at the edges of the two parts being joined is heated until a small pool of molton metal is formed. Then as this pool is made to progress along the junction of the two parts, additional metal is added from a welding rod. The rear edge of the puddle is continuously solidifying while additional metal is becoming molten at the leading edge of the puddle. There are three important parts to the welding operation: the flame, the welding rod, and the method of making the weld.

Fig. 5—The neutral flame has an intense inner cone that is sharply defined. This is surrounded by a bluish outer envelope. During welding, the outer envelope protects the hot metal from oxidation by the air. Fig. 1-4 appeared in Part I.

Fig. 6—The excess acetylene flame has a third zone surrounding the inner cone. This excess acetylene feather is made up of white-hot particles of carbon. The length of the feather with respect to the inner cone is a measure of the amount of excess acetylene.

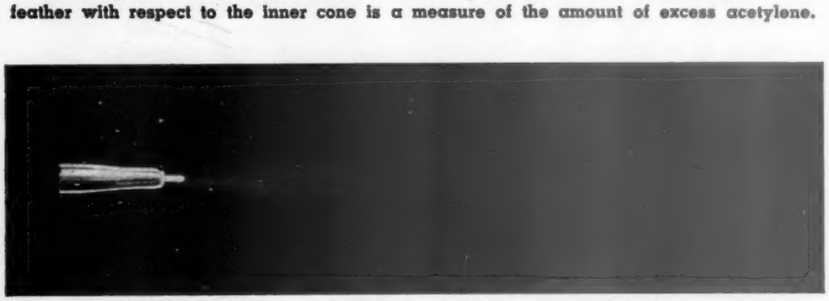


Fig. 7—In the oxidizing flame both the inner cone and outer envelope are smaller. The inner cone has a purplish color. Adjustment to a neutral flame should always be made from the excess acetylene side, not from the oxidizing.

The Flame.

Oxygen and acetylene pass through a suitable mixing device and the mixed gases burn at the blowpipe tip. This furnishes the source of heat for the welding.

There are three definite types of oxy-acetylene flames. One of these, known as the neutral flame, has two distinct parts, an intense white inner cone and a feathery, outer envelope. In the second type, a third cone appears surrounding the inner cone. The third type has but two parts, but the inner cone is shorter, is niched in, and is purplish in color. The basic reason for these flames is that acetylene burns completely in two definite stages.

In the oxy-acetylene process approximately one volume of oxygen is supplied from the cylinder as pure oxygen. This is sufficient for the primary combustion of equation (1), below. The oxygen for the secondary combustion, equation (2), is supplied from the air.

When exactly equal quantities of pure oxygen and acetylene are supplied to the blowpipe, a neutral flame results. In the inner cone of this flame the primary combustion is taking place. In the outer envelope, oxygen from the air is causing the secondary combustion.

If the one-to-one mixture is varied to give an excess of acetylene, the third cone appears in the flame, the excess acetylene feather. Then part of the oxygen for the primary reduction must be supplied from the air.

If, on the other hand, the one-to-one mixture is varied to give an excess of oxygen, the inner cone becomes shorter, is necked in and acquires a purplish tinge. With this type of flame, some of the oxygen for the secondary combustion is supplied through the blowpipe.

The oxy-acetylene flame is the hottest flame known. This fact is explained by a consideration of the chemistry of the flame and, since the chemistry of the flame has an important bearing on

the weld, it is worth at least brief consideration.

Acetylene gas is a compound of two parts carbon and two parts hydrogen. The complete oxidation of acetylene takes place in two complete steps.

$$C_2H_2+O_2 \rightarrow 2CO+H_2+\text{Heat} \quad (1)$$

The products of this primary combustion, carbon monoxide and hydrogen are both combustible.

$$2CO+O_2 \rightarrow 2CO_2+\text{Heat}$$

$$2H_2+O_2 \rightarrow 2H_2O+\text{Heat} \quad (2)$$

From this it becomes evident that $2\frac{1}{2}$ volumes of oxygen are required to burn completely one volume of acetylene.

$$C_2H_2+2\frac{1}{2}O_2 \rightarrow 2CO_2+H_2O+\text{Heat} \quad (1) \text{ and } (2)$$

In oxy-acetylene welding, part of the oxygen required for complete combustion is supplied from the air, as explained above.

The Welding Rod.

As explained earlier, the choice of welding rod for joining S.A.E. X4130 steel depends upon the base metal thickness, in general, although possible subsequent heat-treatment should be taken into consideration.

Welding Technique.

A slightly excess acetylene flame adjustment is recommended for welding with either of the welding rods mentioned and X4130 base metal. One important reason for this is that the slight amount of carbon in the flame has a fluxing action which is of considerable aid in reducing surface oxides; yet such a flame adjustment does not cause carbon pick-up by the base metal. The presence of surface oxide and the fact that the flame adjustment may fluctuate slightly strengthens the argument in favor of a slight excess acetylene feather in the flame. An added advantage of the slightly excess acetylene flame is that it minimizes the overheating of the base metal, and, frequently, the creation of a sharp enough temperature gradient in the base metal to cause the formation of martensite is avoided. (A warning regarding welding operators should be injected at this point. An oxidizing flame is hotter than a slightly excess acetylene or neutral flame. Frequently an operator, in an effort to speed his work, will allow his flame to become slightly oxidizing. This indicates that an effort should be made to give the operator more of an understanding of the effect of the flame upon the resulting weld.)

There are three techniques of weld-metal deposit in use in aircraft welding: forehand ripple, backhand, and "scale" welding.

Forehand Ripple Welding.

In this method the blowpipe is held in the right hand and rod in the left (for a right-handed operator) and the direction of welding is from right to left, thus placing the flame between the completed portion of the weld and the welding rod tip. The puddle is maintained continuously and, in light gauges, metal from the welding rod is added intermittently as needed.

There are one or two things regarding this technique which should be pointed out. The edges of the base metal should be melted first and the puddle thus moved forward. The molten puddle should never be allowed to flow forward onto solid edges as the metal will then not weld. In butt welds this melting of the edges ahead of welding must be done all the way through to the underside of the base metal.

In any welding the flame should be held so that the inner cone no more than just touches the surface of the puddle. It is in the inner cone that the primary combustion is taking place and "digging" the inner cone into the molten puddle will cause oxidation of the steel.

At no time during welding should the air be allowed to touch the white-hot or molten metal. The outer envelope of the flame provides a protection against oxidation and this protection should not be removed until the weld has cooled down at least to a red heat. Drawing the inner cone back away from the weld allows the metal to cool, yet still provides protection against oxidation.

Backhand Technique.

In this method the blowpipe and rod are held the same way, but the direction of welding is from left to right. The advantage is that the flame can be made to play more directly on the basemetal edges ahead of the welding puddle, speeding the welding. The ripple effect at the top of the weld, produced more by the welding rod than the flame, may be somewhat coarser than with forehand welding but not excessively so. The same general precautions as to thorough fusion and avoidance of oxide apply as in forehand welding.

"Scale" Welding.

In this welding method, which can be performed either forehand or backhand, the welding puddle is not maintained continuously. A puddle is created, some welding rod added and the puddle enlarged, and then the flame is withdrawn and the puddle allowed to solidify. Thereupon, a new puddle, overlapping the first is created and the operation repeated.

"Scale" welding is a special-purpose technique developed for use in making fillet welds in which distortion or overheating of a thinner section becomes a problem. An example of a circum-

(Turn to page 210)

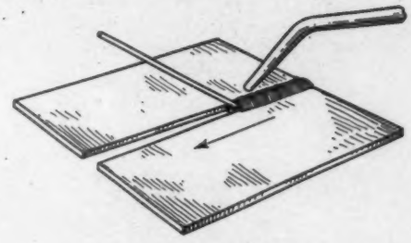


Fig. 8—In forehand technique (for a right-handed operator) welding progresses from right to left. The flame and welding rod are moved alternately from side to side to allow the flame to prepare the metal edges ahead of the welding action.

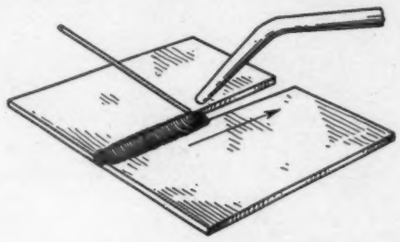


Fig. 9—For a right-handed operator, the welding flame is directed back at the completed weld and the action proceeds from left to right. Because the rod is between the flame and the weld, the welding action can proceed more rapidly than in forehand welding.

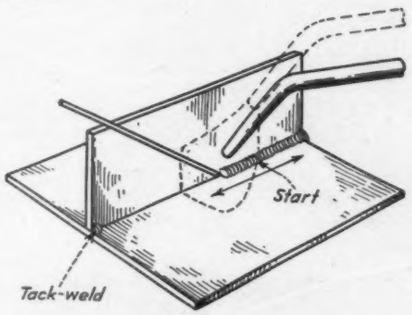


Fig. 10—Scale welding, so-called because the completed weld has the appearance of fishscales, is a special purpose technique. To allow each successive weld puddle to cool, the flame is drawn back. The weld should be continuously protected by the outer flame envelope from oxidation.

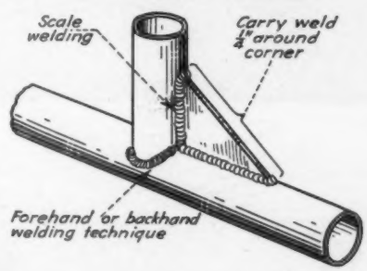


Fig. 11—For attaching light gussets and for other similar welds, scale welding minimizes distortion and makes it easy to avoid overheating. Scale welding should be used only for those types of joints for which it was developed. Any joint can be welded by this technique, but it is slower than forehand or backhand ripple welding.

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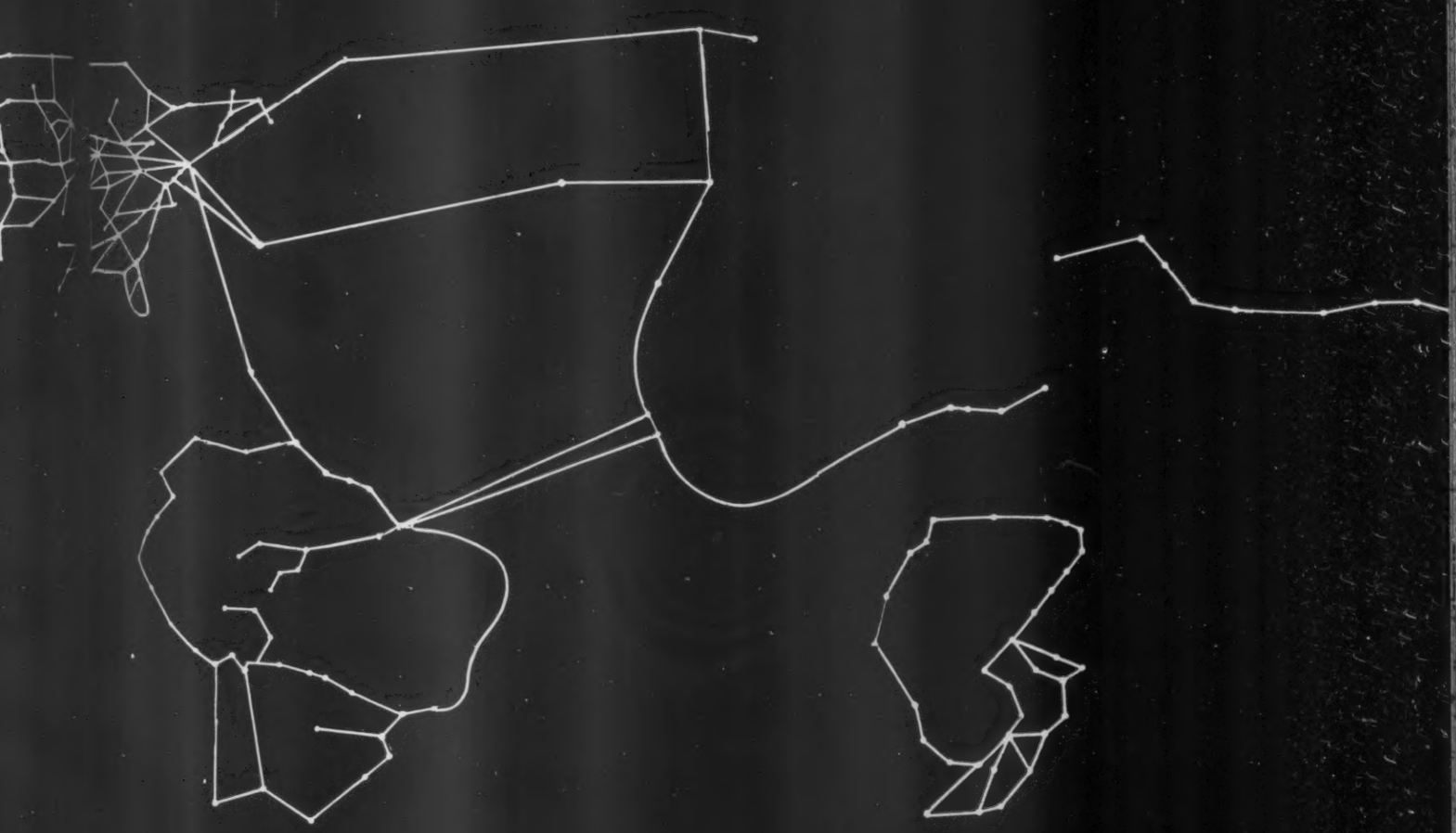

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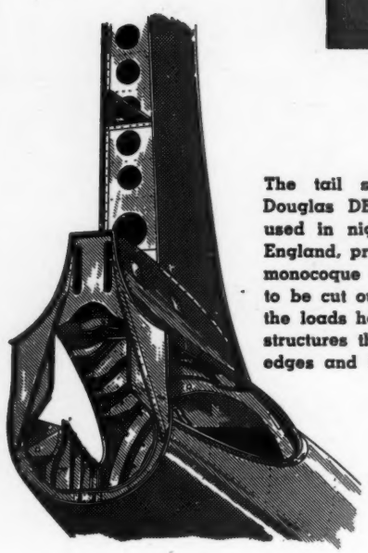
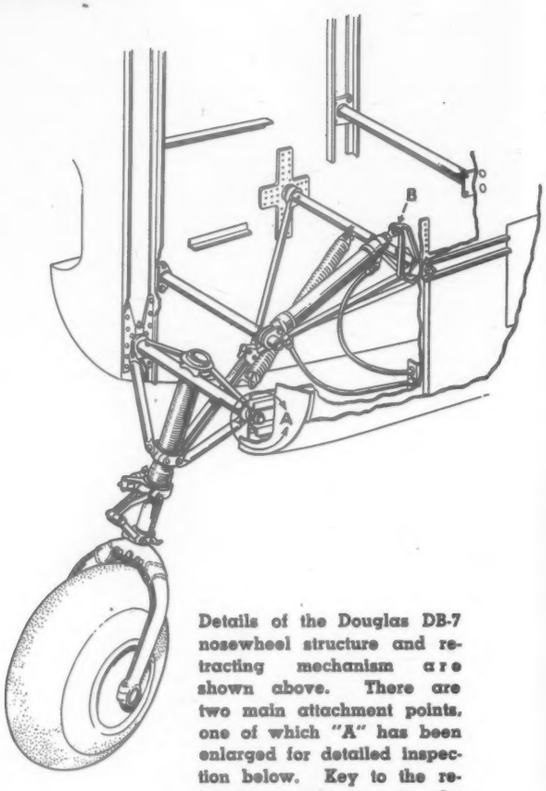
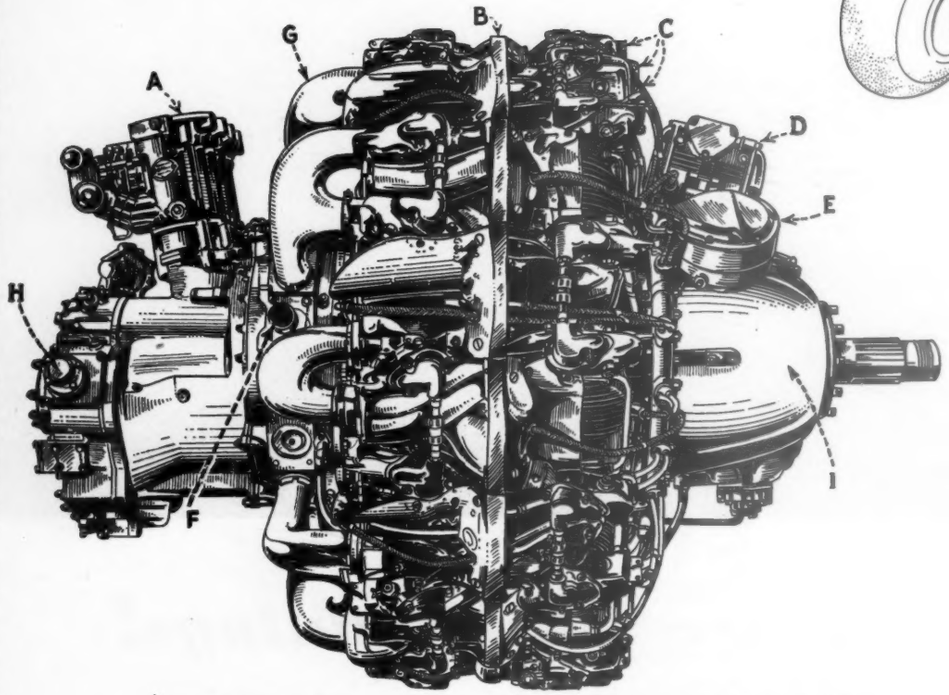


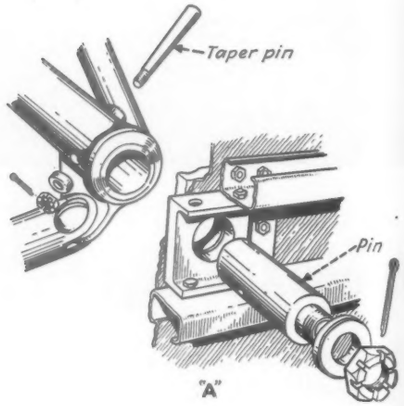
The tail section supporting the fin on the Douglas DB-7 attack bomber, left, now being used in night fighter and other operations in England, presents an excellent example of semi-monocoque construction. Large areas have had to be cut out for insertion of the stabilizers, but the loads have been carried into the supporting structures through the combination of reinforced edges and bulkheads.

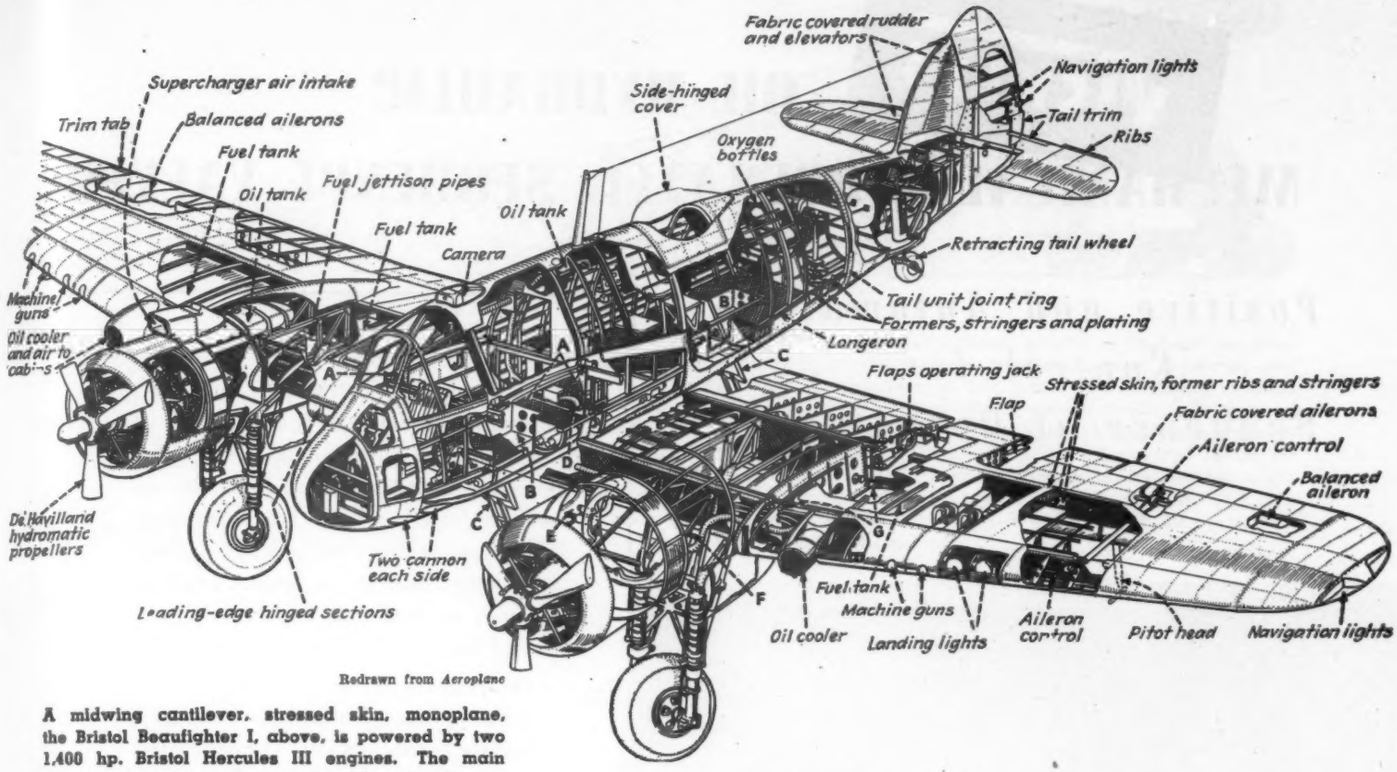


Details of the Douglas DB-7 nosewheel structure and retracting mechanism are shown above. There are two main attachment points, one of which "A" has been enlarged for detailed inspection below. Key to the retracting mechanism is the small torque arm "B" which is actuated by the hydraulic cylinder. In retraction, the Y-strut breaks at the joint and the nosewheel gear swings backwards through the T-beam attached at "A".



The Pratt & Whitney Double Wasp R-2800 is shown above. "A" is the carburetor intake leading to the single stage supercharger. "B" are the newly designed dural baffle plates which seal the periphery of the cowl and the area between the cylinders so that the air is forced directly into the fins of the rear bank of cylinders. "C" are the cowl mounting lugs; "D" is the dual magneto, and "E" the distributor. "F" is an engine mounting bracket. The stainless steel intake pipes "G" are of fork construction and are made in halves. A gun synchronizer drive is located at "H", and "I" is the reduction gear housing.

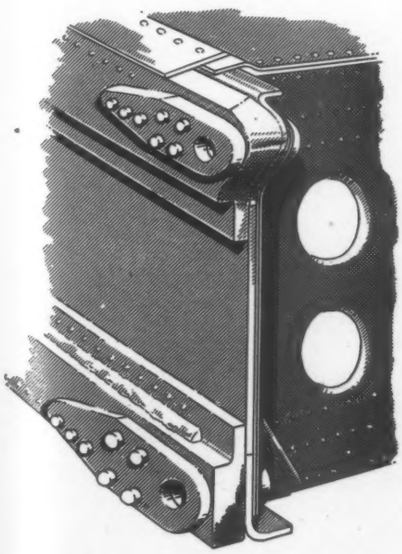




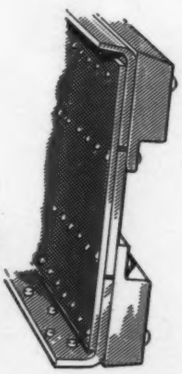
Redrawn from *Aeroplane*

A midwing cantilever, stressed skin, monoplane, the Bristol Beaufighter I, above, is powered by two 1,400 hp. Bristol Hercules III engines. The main components—center plane, outer wing panels, engine nacelles, landing gear, fore end, rear fuselage, stern section and various aerodynamic surfaces—come to final assembly from various "shadow" factories. The fuselage has six main points of attachment to the center wing section, three of which are indicated at "A". An interesting feature is the "escape" hatch "B" which has a tip-up floor "C" acting both as an entrance ladder and emergency exit chute. The cannon are heated by warm air carried by a pipe "D" from the engines. Air from the inlet in the oil cooler is heated in the exhaust manifold "E", and the operating ram for the landing gear is shown at "F". The outer wing panel has four main attachment points, two of which are indicated at "G". Only 2 guns in the port wing.

The Beaufighter departs from the usual aluminum alloy, semi-monocoque design only in that it has two keels, partly shown in the sketch above, running the length of the fuselage. The legs of the rotating seat for the observer are mounted on these keels. Stringers are bulb angle extrusions which intersect the transverse Z-section frames at cut-outs.



At left is shown the end spar of the Bristol Beaufighter center wing section to which one of the two outer wing panel spars is attached by bolts, top and bottom. The top bolt passes through projecting arms from outer wing spar which fit over the center section spar bolt hole. On the bottom attachment, however, in place of the projecting arms, a connecting plate is used in bolting the two spars together.



Spar construction, an end view being shown at right, of the Bristol Beaufighter is unusual due to advances in extrusion practice. The web is of flat sheet and the booms are heavy extrusions of nearly rectangular section (about 3 x 1 in.) with a lip on one side for riveting to the web. Material used is aluminum alloy. (Spar sections redrawn from *Aeroplane*)

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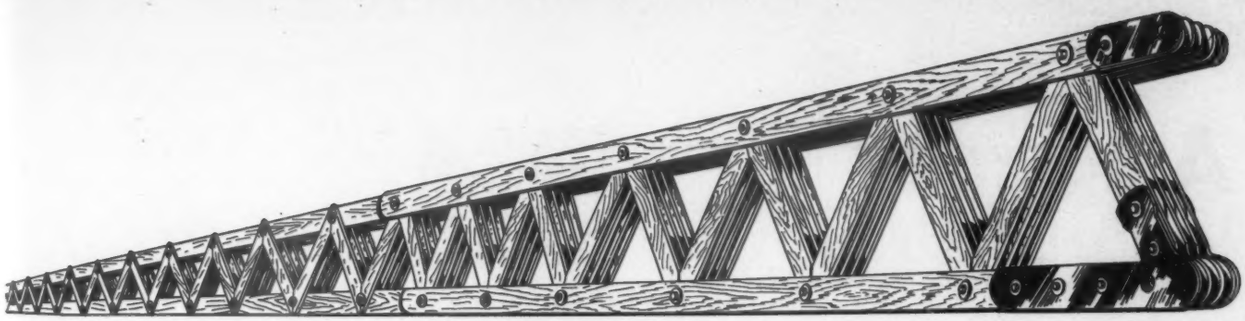
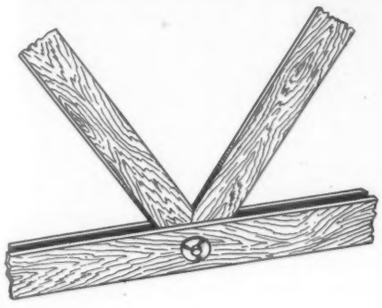
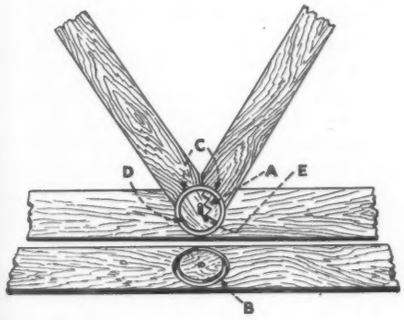
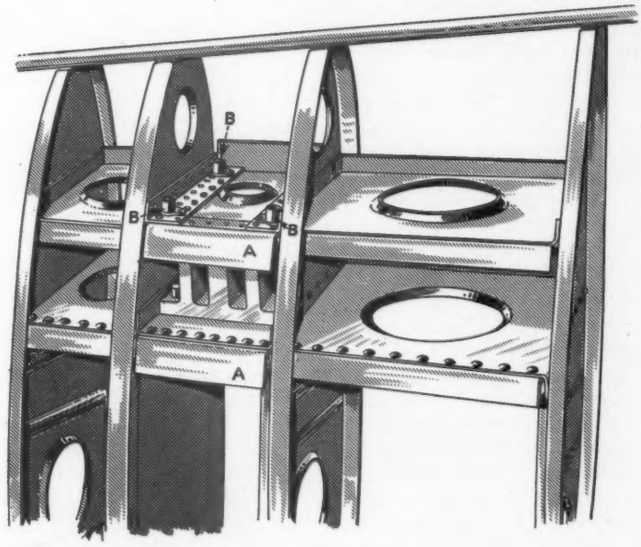




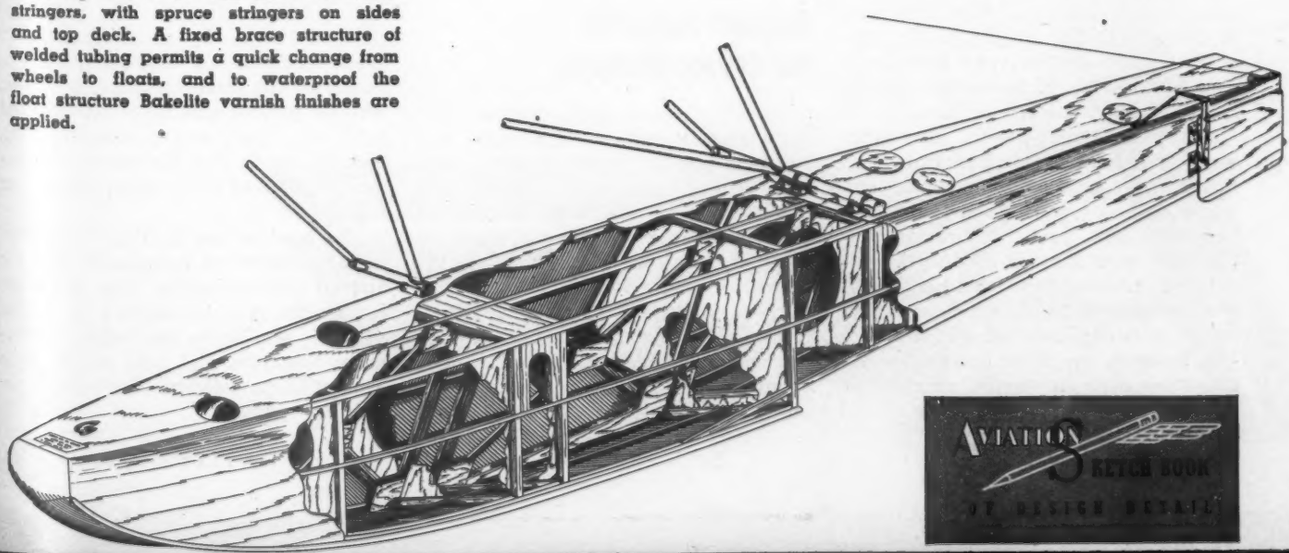
Along with the development of a plastic bonded plywood process in England has come a unique spar joint, left, designed to transfer the loads from one member to another most efficiently. With the shear strength of wood being so low, compared to its tensile strength, the common method of a hole and pin is not very effective when an elastic joint is desired. In place of this, interlocking dowels "A" have been used. In one flange a groove "B" is made into which is inserted a ring "D" which locks in a similar groove "C" in the adjacent web member. This method transfers the load straight from one member to another and the joint always gives central loading on compression members. Then, to hold the assembly together, as shown in the drawing, a bolt is fitted through the center "E". Above is shown a spar constructed by this method.





Constructed entirely of phenol resin bonded plywood, with Plaskon resin glue used for all joints, the Wollam Plywood Float, below, is a semi-monocoque structure with internal bracing and water tight bulkheads. Designed for a gross displacement of 1,360 lb., the new type floats use 5-ply birch material for bottoms, and 3-ply for sides and decks. Rigidity and torsional stiffness is insured by use of an ash keel and chime stringers, with spruce stringers on sides and top deck. A fixed brace structure of welded tubing permits a quick change from wheels to floats, and to waterproof the float structure Bakelite varnish finishes are applied.

The wing section drawing, above, of the Fleetwings Model 33 trainer, shows installation of the landing gear jig. The bulkheads forming the landing gear socket are riveted in place with this jig installed to insure accurate fit. Heavy reinforcement strips "A" are of .093 gage extruded angle. Steel stop nuts "B" serve to hold four through bolts, which are the only landing gear attachment. These bolts are accessible from an access door in the underside of the wing just aft of the landing gear strut.



AVIATION SKETCH BOOK OF DESIGN DETAILS

Aviation RADIO

Dialing the Air Waves with Craig Walsh

Radio Maintenance At United Air Lines

The complications of radio equipment require that where life and safety are concerned it is essential that elaborate precautions be taken to insure that the many pieces of radio apparatus used in a modern airliner continue in normal operation while the plane is in flight. The United Air Lines has attacked this problem by establishing radio-electric shops at LaGuardia Field, New York, Chicago, Salt Lake City, and Oakland. These are in addition to the main overhaul and installation base at Cheyenne. Also, spare equipment is kept ready for use at all of the other stations where a unit which goes bad may be immediately replaced. The defective unit is then forwarded to one of the repair shops. This company also maintains a radio development laboratory at Chicago so that its radio systems are continually being improved and put to new uses.

Each United Mainliner carries three radio receivers and one combination receiver-transmitter. Plans call for the use of two additional receivers and another combination receiver-transmitter for ultra-high frequency operations.

Certain checks are made of the Mainliner's various antennas and radio equipment at every stop and at the end of each flight. In addition, there are visual and mechanical inspections and operational tests of all components of a Mainliner's radio equipment after every 40 and 125 hours of flight. Such inspections and tests are conducted at United's major service stations. Then, at the end of every 700 hrs. of flight, all radio equipment is removed and completely overhauled in the radio-electric shop at the Cheyenne maintenance base.

Thirty-six highly skilled mechanics work with the most modern equipment in the Cheyenne shop, minutely inspecting all radio equipment and adding any necessary new parts. Thorough performance tests are also conducted.

It is interesting to note that all equipment necessary to do navigation and reception is duplicated in some manner. For instance, the plane can receive information over its regular receiver or over its beacon receiver. If one should fail the other is there for emergency use. If the direction finder should cease to function, the pilot can still locate himself by means of the radio compass. Also, if the beacon receiver should fail, the radio compass and the direction finder will enable the pilot to navigate.

After a radio receiver or transmitter is overhauled, it is given a vibration test to simulate normal operating conditions and measurements are made of its characteristics while it is vibrating. In this way any loose connections or loose parts are detected before they can do any harm. If the tubes perform properly in this test it is known that they are in good condition and that they do not need replacement. It is interesting to note that new radio equipment purchased or built by United Air Lines not only must meet certain mechanical requirements, but also must pass severe tests if these have not already been conducted by the manufacturer. Such tests include four hours on a vibration table at frequencies of from 30 to 60 cycles per second and at amplitude sufficient for a vertical acceleration of 10 Gs.; 48 hrs. in a humidity chamber at 95 deg. humidity and temperature of 50 C.; a temperature test in which the equipment is subjected to temperatures ranging from +55 to −35 deg. C.; a test in an altitude chamber at variable pressures from sea level to 31,000 ft., and a drop test in which the equipment is subjected to at least 100 free drops of from 16 to 18 inches.

Azimuth Indicator for Ground Stations

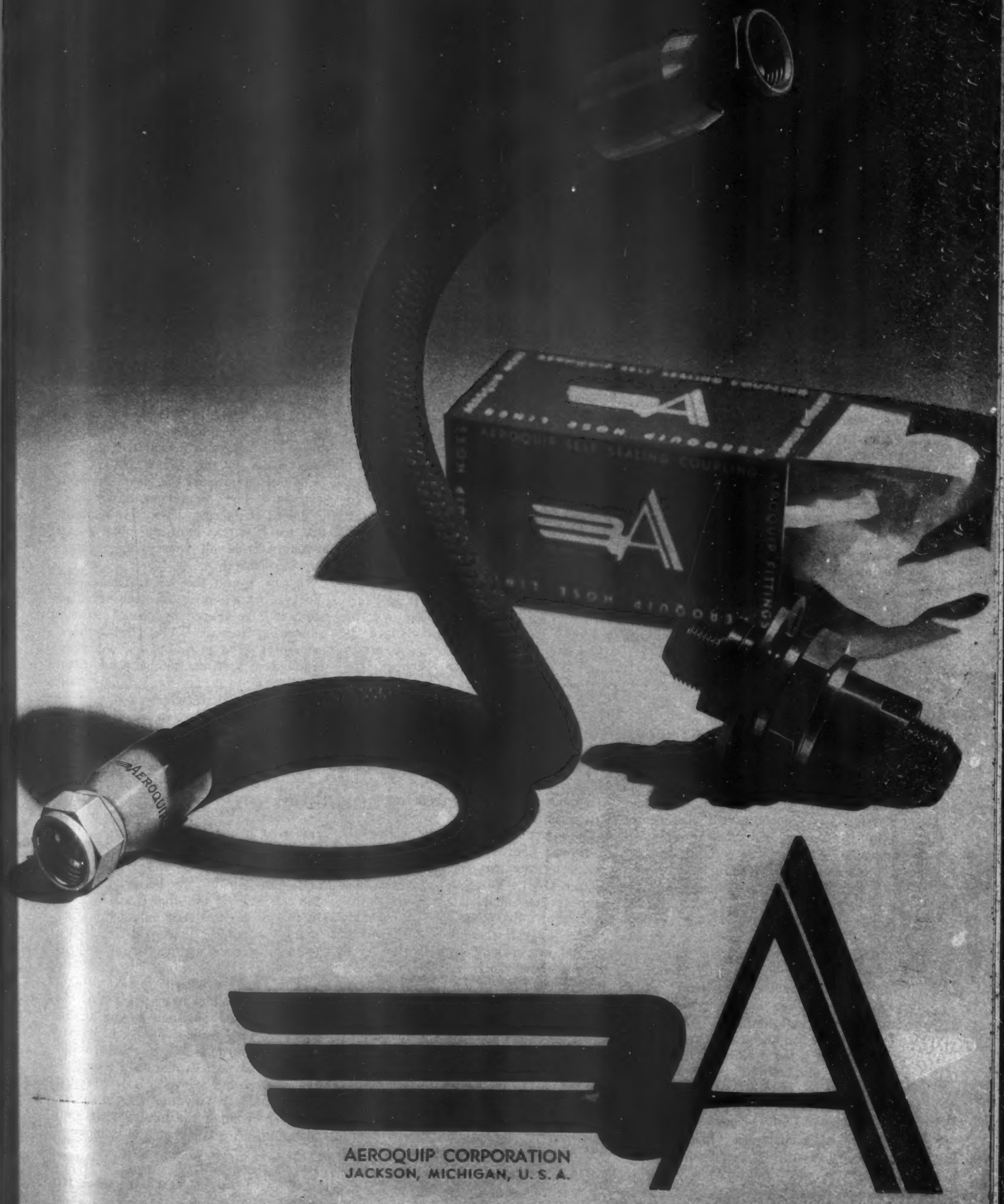
For a number of years direction finding equipment using the directional loop has been used to enable airplane pilots to determine their positions under conditions of poor visibility. Because of the necessity of a skilled operator to work the equipment and the time required to make a reading it was necessary for the plane to make a special transmission for the direction-finding determination. Apparatus which will determine a plane's direction instantly and automatically has been developed by Bell Telephone Laboratories according to the *Bell Laboratories Record* for November. It is an azimuth-indicating radio receiver, operating in the 2 to 7 megacycle band, which gives a visual indication of the direction of the source of any radio waves to which the receiver is tuned. The collector, or antenna, system may be located at a site free from electrical noise, while the indicator panel may be located at a regular operating point where personnel is available for observing the directional indications.

The antenna system consists of four vertical dipoles located at the corners of a square with a fifth dipole at the center. The four corner antennas are used for determining direction. The center antenna serves as a reference of radio-frequency phase to permit differentiation between directions 180 degrees apart, and also it receives the normal communication signals. This form of antenna responds only to the vertical component of the electric field, since the horizontal component is cancelled out.

Each pair of directional dipoles is connected to the input of a pair of modulators which are also supplied with an audio-modulating frequency. The carrier and modulating frequency are both suppressed only the side-bands remain. The outputs of the directional modulators, together with the output of the center antenna, are then combined and passed to the radio receiver. The three components are separated at the output of the receiver and the signal is fed to a loudspeaker, and the two directional components to the plates of a cathode ray tube. The cathode ray tube has two pairs of deflecting plates at right angles to each other. The rectified output of one pair of dipoles tends to deflect the spot along the line of one pair of plates and the output of the other pair of dipoles along the line of the other pair of plates. The indication on the screen will then be a straight line whose direction depends upon the relative strengths of directional signals applied to the deflecting plates. If there were only the two directional sidebands at the detector input in the radio receiver there would be uncertainty between directions 180 degrees apart. The output of the center antenna, however, which is present with the two directional sidebands, serves as a reference of sign, with the result that the bearing is correctly indicated at all times during the flight.

The receiver has facilities for choosing any one of ten frequencies used for aircraft communication. Any of the ten frequencies may be selected by a dial which is similar to the ordinary automatic telephone dial, and a light in a bank of lamps indicates which frequency is being received.

AEROQUIP HOSE LINES



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AEROQUIP SELF SEALING COUPLINGS

Aviation's Changing Trends

By Selig Altschul

WHILE air line securities were sharply lowered on the news of the twin plane crash, this weakness proved to be of a temporary nature and the group showed remarkable resiliency in recuperating most of its losses. In years gone by, a plane disaster depressed air line equities for a sustained period and required considerable time to refurbish investor confidence in the industry.

This changed market behavior is far more significant than a mere speculative gyration. The stock exchange is not only a medium through which securities are bought and sold, but to many it is a barometer and a reflection of informed opinion—opinion which backs its judgment with hard cash. Viewed in this light, the present action of air line equities is encouraging to those who are optimistic as to the near-term and future outlook of the industry.

It was a number of accidents late in 1940 together with poor flying conditions during the early part of 1941 which were primarily responsible for the inferior industry earnings reported for the first half of this year. The market sensed these and other restrictive factors and air line securities declined in anticipation of the declining earnings as subsequently confirmed by published reports.

The relative firmer markets prevailing after the recent plane distasters may in part be due to the minimum of "scare" publicity present as compared with that generated by previous catastrophes. More deserving of the headlines were more momentous events of the times such as the torpedoing of an American warship and the belligerent attitude of John L. Lewis. Probably of greatest importance is the basic recognition that air transportation is too firmly established to be seriously retarded by occasional plane crashes. In this instance, there was again present the tendency of traffic to decline. To what extent this may be attributed to the accidents may be difficult to determine. The seasonal decline had already set in and bad weather was responsible for many flight cancellations. The traffic levels in the months immediately ahead will provide a more accurate test of the effects of the October disasters. The exigencies of defense activity, however, may continue to bolster air line travel regardless.

The individual air line equities showed diverse trends and surprisingly enough the equities recording the greatest losses were not of the companies involved in the accidents.

Eastern Air Lines in recent weeks has been particularly "heavy"—this despite the fact that the company is shortly about to enter its highly profitable season. Investment trust managements appear to be confused in their attitude towards this company. For example, during the third quarter, two investment trusts, including the Lehman Corp., purchased a total of 5,200 shares of Eastern. On the other hand, during this same period, three funds, including State Street, sold an aggregate of 8,200 shares of this stock. The gradual decline of Eastern in past weeks may be belated recognition of pending developments.

The CAB in a recent action denied Eastern's petition to dismiss the application of other carriers for route certificates which would create intense competition for the company. It is not generally appreciated that a large measure of Eastern's success stems from its lack of competition. This advantage is twofold: The company has a virtual monopoly on the business in its area—and operating costs—particularly sales expense, are lower. Should present regulatory trends continue, it is likely Eastern's monopoly ultimately will be no more. The CAB in previous decisions has sought to encourage a certain amount of competition between the various lines.

Long overdue is the examiner's report on Eastern's mail rate structure. In view of the uncertainty created by a similar report on American Airlines and the forthcoming clarification expected from the CAB on this issue, considerable anxiety will be present until this rate question is settled.

As a matter of fact, the entire air transport industry will be vitally affected by any rate formula enunciated by the CAB. The whole problem has been further complicated by the introduction of a Brookings Institution study which suggests that the CAB exercise its full rate-making authority to revise air passenger fares. This recommendation is pertinent in the case of Eastern, as that carrier appears to be less dependent upon mail revenues than any other air line and yet has shown highly profitable operations.

A passenger rate reduction ordered for one air line will probably set a precedent for the industry and can unleash untold repercussions. For example, lower passenger fares will hurt the unprofitable lines which may then require higher mail pay to meet their deficits. Lower air rates will probably draw much more business from the ground carriers and this may conflict with the public interest by adding to the woes of the railroads, for example. Yet, it is difficult to see how this conflict can be effectively avoided. Regardless of official CAB action, it is likely that in a post-war period, improved airplane construction and design, and expanded personnel will all be at the disposal of commercial aviation. The natural result is a substantial reduction in operating costs—which in turn will make possible lower rates all along the line. Under those circumstances, how secure is the approximately $100,000,000 now going to the railroads annually for mail compensation? What of the $417,000,000 in yearly passenger income now received by the railroad industry? More importantly, how much of a dent will the air lines make in the $35,000,000,000 in freight revenues paid the steam carriers last year? The potential to the air lines is indeed staggering when it is realized that for 1940, the industry's total gross revenues from all sources aggregated but $75,000,000.

In any event, the air transport industry's future progress and development will be shaped by official actions emanating from the CAB. Until greater certainty as to a regulatory policy is established, first one company and then another will be on the anxious seat awaiting final judgment.

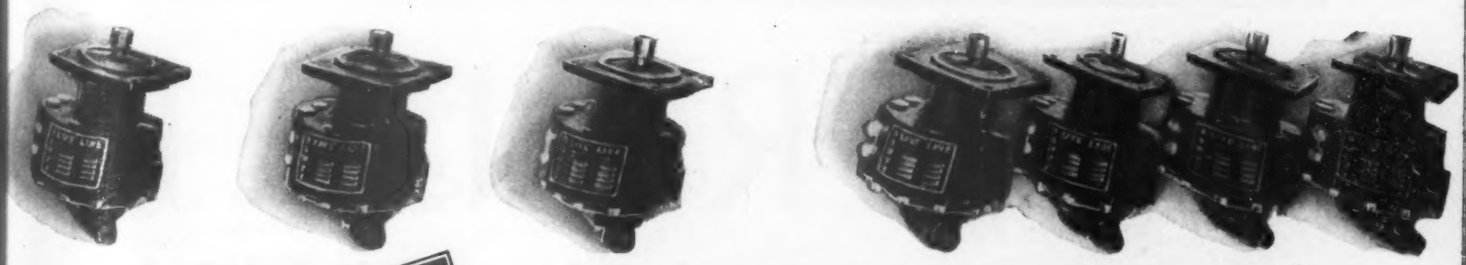
The favorable action of American Airlines may not only reflect its highly favorable trend of earnings but may also indicate that the company may not be required to return part of its 1940 earnings as recommended by a CAB examiner. (This whole question was reviewed in detail in the August issue of AVIATION). Since the release of this examiner's report, no end of discussion and apprehension has been created on the subject and the final CAB findings in this matter will not only be of vital import to America but will establish a momentous decision for the industry as a whole.

The most backward, marketwise, of the major air lines has been TWA. As there has been consistent buying in this stock by the Hughes Tool Co., it may be safe to surmise that this issue, without such support, would have been selling at much lower levels. Latest reports show Hughes as owning 416,650 shares, or 44 percent of the total 950,000 outstanding. A glance at the company's

(Turn to page 214)

The Avro Anson

powered with Jacobs L-6MB engines, now being manufactured in Canada, are equipped with Dowty Live-Line hydraulics.



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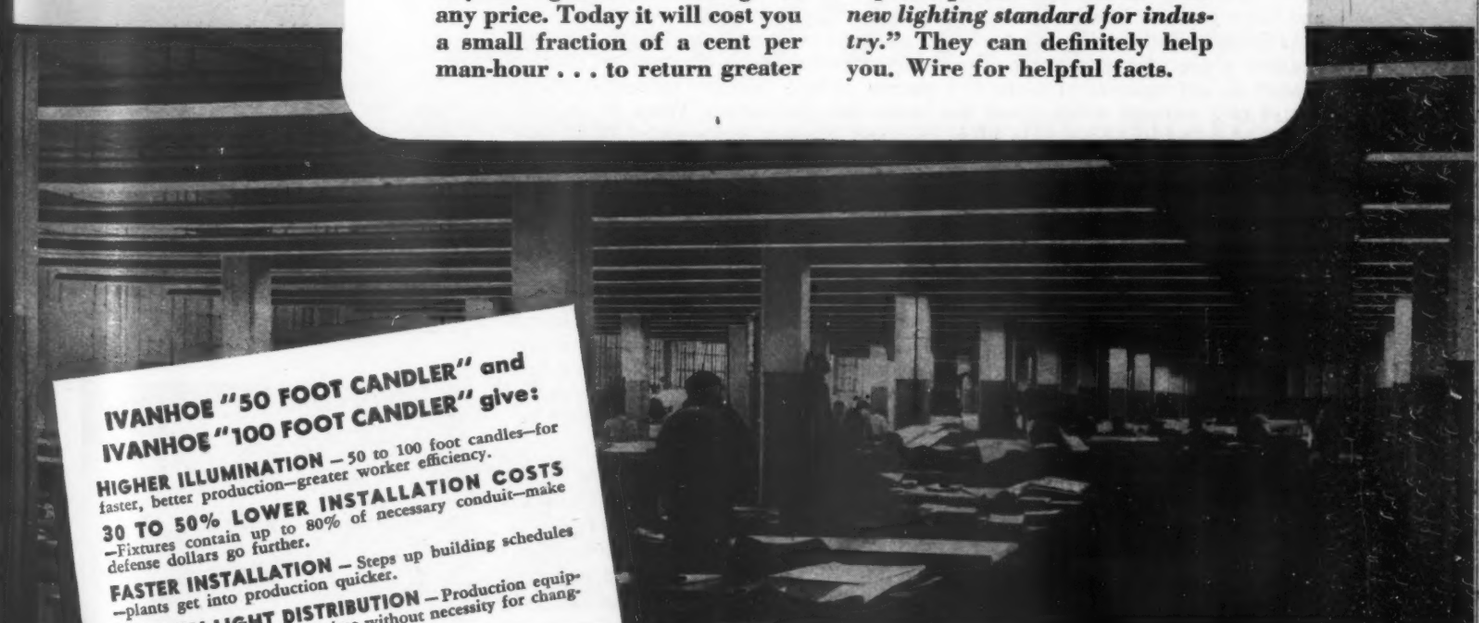

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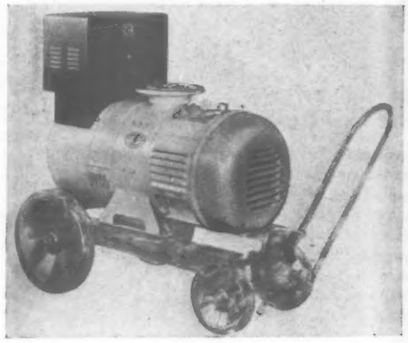
BUYER'S LOG BOOK

What's New in Accessories, Materials, Supplies, and Equipment

Refrigerated welding has been made commercially available by *Progressive Welder Co.*, 3050 E. Outer Drive, Detroit, Mich., in the development of refrigerating units for spot welding machines. When used in combination with spot welders, the unit reduces electrode temperature to a point where, in spite of the high heat necessary to produce a weld, the electrodes will be continually covered with frost. This temperature reduction is said to have so increased point life that 10 minute runs, continuously, at 100 welds per minute without point dressing are not unusual for the combination of a Progressive 3-phase aluminum welder and the new refrigerating unit. It is also available for other makes of aluminum and stainless steel welders.—AVIATION, *December, 1941.*

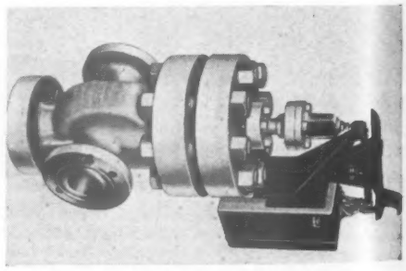
Progressive refrigerated welding unit

Crater eliminator for arc welding is announced by *Wilson Welder & Metals Co.*, 60 E. 42nd St., New York, N. Y., in its "Stroco" Electric Arc Crater Eliminator for use where presence of typical crater at the end of a weld deposit is objectionable. The "Stroco" Crater Eliminator is an auxiliary device mounted on body of the arc welding generator. Control is by means of a 3-position button located on electrode holder. During usual progress of the weld, switch is in neutral position and device is entirely inoperative. When operator is about to break his arc either because he is approaching the end of one electrode or end of one weld, he presses button backwards into the "On" position. This brings the "Stroco" Crater Eliminator into play and causes the arc to fade out gradually until arc voltage becomes so low that it can no longer deposit any metal. Where sections being joined become smaller so that it is desirable to reduce current density for limited period, button can be retracted to make slight reduction in welding current, then advanced to "Off" so remainder of weld can be completed with reduced current. Or, if return to original current is wanted, release of pressure on button will let it swing into neutral which will cause increase of current to original value.—AVIATION, *December, 1941.*



Wilson "Stroco" Arc Crater Eliminator

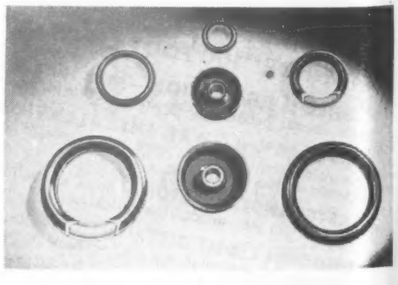
For high pressure installation from 1800 to 2500 lb., the Ashcroft Power Control Valve is announced by *Consolidated Safety Valve Div.* of Manning, Maxwell & Moore, Inc., Bridgeport, Conn. The new power control valve is said to effect a large saving over the 4 percent required for the spring loaded safety valves. Immediate results are more accurately balanced boiler operation at peak loads and more uniform line pressure. Principle of operation of the Ashcroft Valve is as follows: Boiler drum or superheater outlet pressure or steam header pressure actuates a pressure control set at popping pressure, which operates an electric contact on difference of pressure of 1 percent or less. Electric current is transmitted to a solenoid which opens and closes the pilot valve. When it opens it unbalances pressure over main valve disc and it opens and remains open until pilot valve is closed. Whole cycle of operation is almost instantaneous. Power control valve opens exactly at popping pressure and closes cleanly with extremely low blow-down. The Ashcroft Valve is intended as a supplementary operating valve to conserve power of steam plant.—AVIATION, *December, 1941.*



Cons. Safety Ashcroft Control Valve

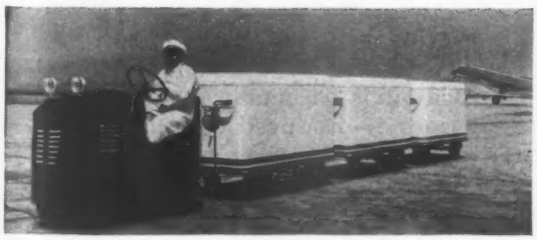
New Fire Wall Sealer, made by *Presstite Engineering Co.*, 3900 Chouteau Ave., St. Louis, Mo., is used in sealing the joint of the fire wall assembly in certain military planes. In liquid form, compound is easily applied with a brush and it is claimed to set and dry to a tough, permanently flexible, resilient, rubber-like body. It is said not to be affected by oil, gasoline, grease or water, and is used for preventing gases, fumes, oils, etc., from entering pilot's cockpit.—AVIATION, *December, 1941.*

The new defense material, Ameripol Synthetic Rubber, has been successfully compounded in the laboratories of *Miller Rubber Co., Inc.*, Akron, Ohio, in accord with new exclusive formula which is said to make it the ideal molding material for oil seals, v-type packings, accumulator diaphragms and all parts on airplane hydraulic systems. It is particularly noted for its resistance to sub-zero temperatures, exceptionally low oil absorption, low friction, and ability to be fabricated to close tolerances and high resistance to metal corrosion, heat, light and ozone.—AVIATION, *December, 1941.*



Miller molded Ameripol parts

"Clark" Fork Truck, unloading motors for Lockheed at Burbank, Calif. This machine lifts 3 tons, carries the load at 7 m.p.h., tiers it to 104 in. in 15 sec.



Three-wheeled "Clarkat" towing commissary trailers loaded with freshly prepared meals for United Air Lines "Mainliners" at Salt Lake station. "Clarkat" is built in two sizes, towing as much as 40 tons.

"Clarktor-6" four-wheeled tractor, about to tow B-25 Twin Engine Bomber onto flight ramp at North American Aviation Co., Inglewood, Calif.

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"Clarks"—fork and platform trucks and towing tractors—unload and store materials and parts, keep production machines supplied with work, tow ships in factory, hangar and airfield, service them at airports. "Clarks" are gas-powered, capable of 24-hr. continuous service. Over 70 models serving the aviation industry. Write for catalogs.

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Type PV-7 high pressure 4-way selector valve

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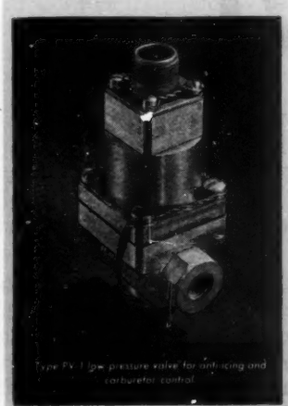

Type PV-1 low pressure valve for anti-icing and carburetor control

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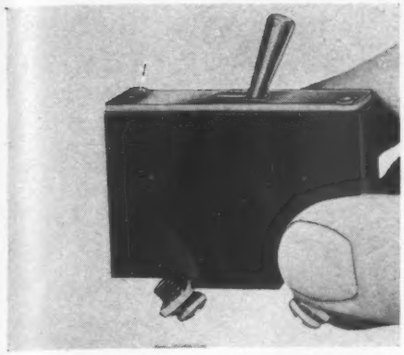
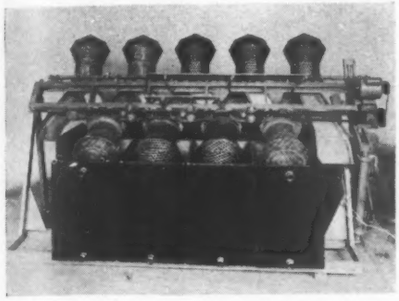


Square D Class 9300 Circuit Breaker

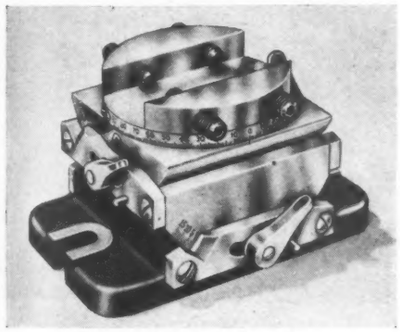
Designed particularly for circuit protection on aircraft by the *Square D Co.*, 6060 Rivard St., Detroit, Mich., the Class 9300 Circuit Breaker is a new combination of circuit breaker and "on" and "off" switch. Available in a variety of ranges, including 10, 15, 20, 25, 35 and 50 amp. sizes, all are offered in same small enclosure, 2⅞ in. long by 1⅝ in. deep and ¾ in. wide. It is completely interchangeable with and same size as standard "on" and "off" switch. This compact circuit breaker saves space, weight and wiring time; eliminates fuses and provides calibrated protection for each circuit, all within one sealed housing. For "on" and "off", the toggle lever is moved manually as with ordinary switch. If dangerous over-current is present, toggle lever snaps to "off". The 9300 Circuit Breaker is non-trip free, but when manually released, breaker will trip if over-current is still present.—AVIATION, *December, 1941.*



Udylite automatic plating machine

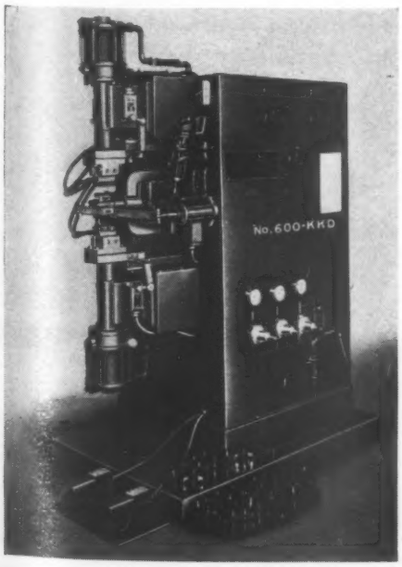
To step up production on small-hole drilling and tapping operations, a new series of two, three and four-spindle drilling machines have been introduced by *Atlas Press Co.*, Kalamazoo, Mich. Drilling heads incorporate well-known ball bearing equipped floating drive featured in all Atlas heavy drill presses. Table weight of the three and four-spindle machine is reported at 575 lb., furnishing a solid support for smooth movement of heavy jigs, fixtures and parts in production quantities. Each drilling head is equipped with own motor mounting and new type of positioning control with crank handle. Table surface (3 and 4-spindle machines) 21x54 in. spindle travel 4 in.—AVIATION, *December, 1941.*

Development of a full automatic barrel cleaning and plating machine for handling small parts in bulk has been announced by *Udylite Corp.*, Detroit, Mich. The machine is being used to zinc and cadmium plate aircraft engine parts continuously. Said to offer radical improvements over existing machinery, it makes possible complete finishing of small parts with minimum of labor expense. It is completely automatic in that the parts are progressively subjected to various cleaning, rinsing, pickling, plating and drying operations without manual handling. The only manual labor required is at either end of machine, eliminating 8 to 10 hand operations. Operators need no rubber gloves, boots or aprons, and do not come in contact with material until after it is discharged clean and dry. Tanks in plating barrels have sufficient anode and solution capacity to maintain correct metal content without addition of metal in salt form.—AVIATION, *December, 1941.*



Hammond Any-Angle Tool Vise

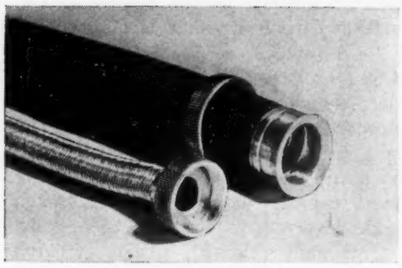
Any-Angle Tool Vise, designed for grinding chip-breaker grooves into tips of carbide tools and formerly furnished only as a part of the Hammond "4" Chip Breaker grinder, has now been placed on the market as a separate unit by *Hammond Machinery Builders, Inc.*, 1638 Douglas Ave., Kalamazoo, Mich. Complete in itself, the vise is mounted on a lug which is easily fitted to a machine table. New vise is constructed on a double-cradle principle permitting adjustment of grinding angles on three separate planes. Two closely machined steel blocks, rounded on bottom, are cradled into each other at right angles. After adjustment, they are solidly locked together by tightening cam locks operating in machined segments at ends of respective blocks. Absolutely no vibration or deflection is permitted, it is said.—AVIATION, *December, 1941.*



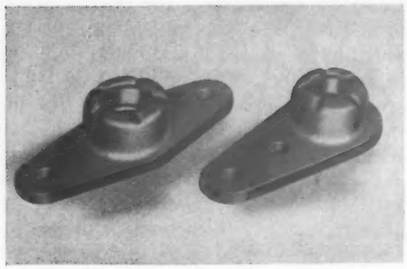
Eisler Projection Spot Welder

Addition of a new series No. 7 line of Power Squaring Shears built in 4 to 12 foot cutting lengths and capacities from ¼ in. to 10 gage is brought out by *Niagara Machine & Tool Works*, Buffalo, N. Y. These shears are of underdrive design with drive including flywheel, gearing, clutch, eccentrics and connections completely enclosed and operating in a bath of oil. Camber or curl of narrow strips is said to be eliminated, and more working strokes per hour are possible by high operating speed of 60 strokes per min.—AVIATION, *December, 1941.*

A special Air-Operated Projection Spot Welder, No. 600-KKD, was placed on the market recently by *Eisler Engineering Co., Inc.*, 740 So. 13th St., Newark, N. J. This machine is arranged with special welding jigs and fixtures for welding fins to steel tubing. No individual jig is needed for loading the work. There are 56 points of heat control, and the transformer secondary, welding dies, and mandrel are water-cooled throughout. The rotating mandrel is operated by air and fully automatically controlled. Pressure for each set of air cylinders can be regulated individually to meet any specific requirement. The machine is so wired that the ejector mechanism cannot operate while the welding dies are in motion, nor will the welding dies operate while the ejector mechanism is in motion. Actual welding time is controlled by automatic timing equipment. Production is about 200 finished pieces per hour.—AVIATION, *December, 1941.*



Searle Amerflex-26 conduit



Elastic Stop Nut Blind Mounting Nuts

A synthetically covered flexible electrical conduit, Amerflex-26, is being produced by *Searle Aero Industries, Inc.,* Hawthorne, Calif. This conduit, it is said, possesses 30 to 40 percent longer life because of greater flexibility, heat resistance, and oil and solvent resistance, and is 47 to 54 percent lighter in weight. It is specifically adapted for use in motor nacelles, behind instrument panels, and inside airplanes where wiring might be exposed to grease oil or dust, although it is available without covering, where such protection is not required. Any length up to 25 ft., with or without standard or special fittings, may be supplied.—AVIATION, *December, 1941.*

To provide vibration-proof fastenings in aircraft construction, *Elastic Stop Nut Corp.,* 2332 Vauxhall Rd., Union, N. J., now offer their anchor type nuts for blind mounting applications. The bolts, which are inserted from the outside, pass first through the removable plate used to cover hand holes, inspection openings, etc., and then through the structure into the stationary nuts. Every nut incorporates basic Elastic Stop self-locking feature, and the nuts are offered in a wide range of sizes, materials and thread systems.—AVIATION, *December, 1941.*

Ace Spot Welders made by *Pier Equipment Mfg. Co.,* Milton & Cross Sts., Benton Harbor, Mich., are now offered with a new type of precision Timer for automatically controlling welding time period. Thus equipped, welding time can be quickly selected, hourly production increased, and uniform welds assured, company claims. Provision has been made for simple easy adjustment, there being three concentric scales on a convenient direct-reading dial. Adjustment range is from 3 to 47 cycles (3/60ths to 47/60ths of a second), calibrated in one cycle steps. Once timing dial is set for a job, depressing of pedal is followed by closing of welder contactor, energizing welding circuit and timing element. At end of selected time period, contactor is automatically tripped and welding circuit opened.—AVIATION, *December, 1941.*

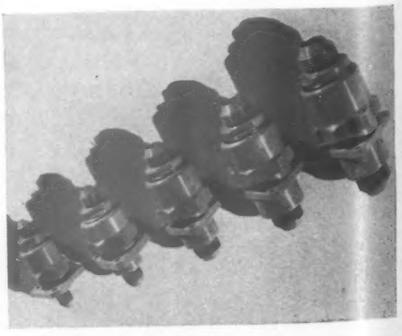
Simplicity and ease of handling are features of the new portable engine assembly stand announced by *Aviation Dept., Whiting Corp.,* Harvey, Ill. Originally designed by Karl O. Larson, chief engineer of Northwest Airlines, it has been service tested and is available for all makes of radial engines.—AVIATION, *December, 1941.*

A complete new line of hydraulic disconnect couplings is announced by Bendix Aviation, Ltd., Union Air Terminal, Burbank, Calif. The Bendix coupling is so designed that, when attached, the area of passage through the valve is everywhere equivalent to the inside diameter of a standard fitting. As soon as the coupling nut is loosened, sleeve valves in the two halves of the coupling close so that no fluid is lost from either side of the line. The coupling nut seals with a very light pressure so that it is never necessary to tighten it with a wrench.—AVIATION, *December, 1941.*

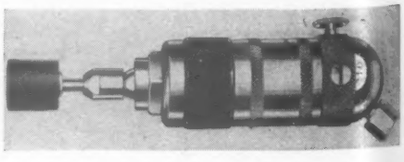
Only 6¼ in. in overall length, and with a speed of 17,000 r.p.m. for wheels up to 2 in., the recently announced Aro Model 22BGS Grinder has been designed by *Aro Equipment Corp.,* Bryan, Ohio, as a pneumatic grinder that is compact and sufficiently light for one-hand operation, yet rugged and powerful. New grinder is said to have undergone extensive tests in actual use in aircraft and other industrial plants throughout the country. It is equipped with large precision type ball bearings, and is available with either lever or button throttle and with spindle extension and collets of various sizes.—AVIATION, *December, 1941.*

Pier precision Timer for Welding

Whiting portable engine stand



Bendix disconnect couplings



Aro Model 22BGS Grinder

DEFY ERASURE-GHOSTS
with this new tracing cloth

Here is a tracing cloth that holds erasure scars at a minimum—that won't show water marks or perspiration stains. Now you can have clean tracings, in pencil or ink, free from these untidy "ghosts" that reproduce on blueprints!

For PHOENIX is ghost-proofed by a remarkable new process that defies moisture and gives you an unusually durable working surface. You can use harder pencils with this improved cloth and get sharper lines with less tendency to smudge. Even 6H lines show clearly, and reproduce sharply! Erasing does not mar the drawing surface; erased areas take pencil smoothly—and ink without feathering. Its new white color and increased transparency give you excellent drawing contrast and produce strong blueprints.

Let PHOENIX prove its virtues on your own drawing board. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

EST. 1867
KEUFFEL & ESSER CO.
NEW YORK · HOBOKEN, N. J.
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PHOENIX DEFIES MOISTURE GHOSTS

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*

PHOENIX LESSENS SMUDGE GHOSTS

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.

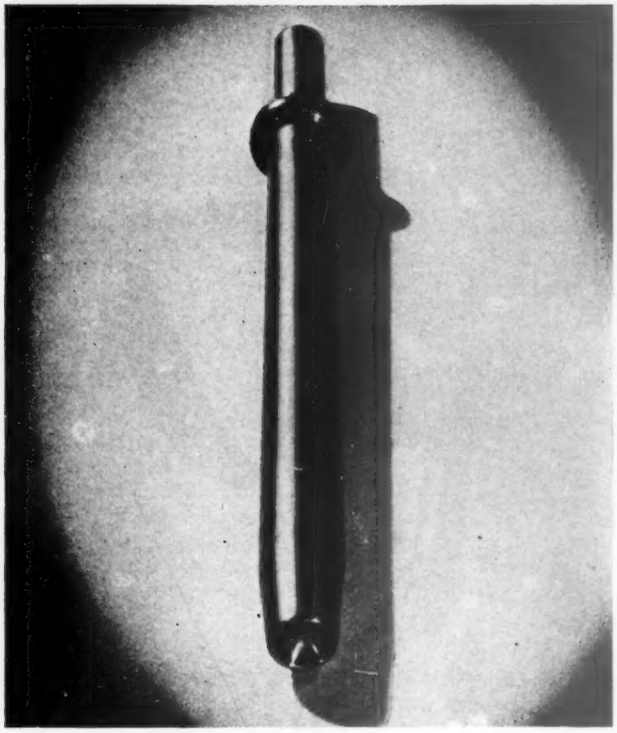
PHOENIX REDUCES ERASURE GHOSTS

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

K&E
Phoenix
REG. U.S. PAT. OFF.
TRACING CLOTH
for pencil *and* ink

HERE'S SOMETHING NEW* IN RIVET SETS



*Cupforged—Comparameter Inspected

For Longer Wear and Greater Precision

Keep out in front! Make it *better* or don't make it! There's no digression from this policy at Aero Tool. Typical are these years-ahead Flush and Cup Type Rivet Sets.

Aero Tool Rivet Sets are "Cupforged" to last longer and retain their precise shapes—They're Microglass Finished—won't mar the most delicate skin or surface—like every Aero Tool Product, they're Comparameter Inspected for surface finish and dimensional accuracy. Available in all standard sizes and lengths, Brazier or Round Head Types.

Send (on your firm letterhead, please) for this illustrated 36 page catalog of Production and Maintenance Tools including Bucking Bars, Dimpling Tools, Stop Countersinks, Back Spotfacers, Skin Clamps, Drill Adaptors and Drill Bushings all to Aero Tool Standards.

AERO TOOL CO.

CUPFORGED AVIATION TOOLS

AERO TOOL COMPANY, 233 WEST OLIVE AVENUE, BURBANK, CALIF.

★★★ VICTORY ★★★ VICTORY ★★★ VICTORY ★★★ VICTORY ★★★ VICTORY ★★★ VICTORY ★★★ VICTORY ★★★

PILOTS for DEFENS

TRAIN *in* SILVAIRES

The more pilots we train now, the longer we'll keep enemies from our shores. Silvaire-trained pilots are fighting with the R. A. F. and flying with the Air Forces of the United States on active defense duty. The production of superior Silvaire airplanes makes thorough defense flight training available inexpensively to CPTP students, Home Guard members and students of most CAA approved schools. Pilots for defense are training in the ship preferred by experienced instructors —the SILVAIRE.

See and fly the new 80 Silvaire DeLuxe . . . cruising speed 110 m.p.h., range 550 miles . . . starter, muffler, 12-volt lights and battery, etc. . . . available for night and blind flight instruction.

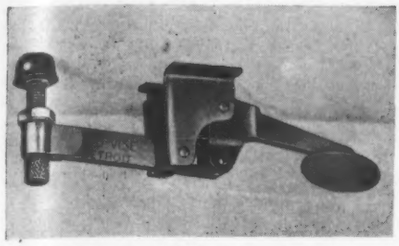
Avoid delay — present prices cannot be guaranteed.

SILVAIRE

A Defense Product of
LUSCOMBE AIRPLANE CORPORATION

LET'S GO! U.S.A. KEEP 'EM FLYING!

WEST TRENTON NEW JERSEY

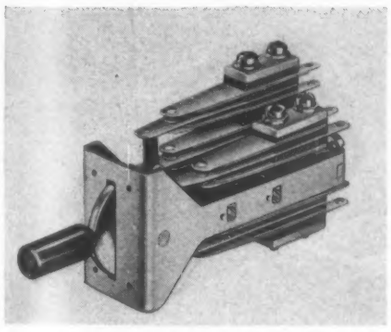


Knu-Vise #830 Midget Toggle Clamp

New Midget Toggle Clamp is announced by *Knu-Vise, Inc.*, 16837 Hamilton Ave., Detroit, Mich. Furnished complete with spindle and rubber cap, measuring but 4 in. x 1½, a pressure in excess of 500 lb. is said to be obtained with this model #830 clamp. Because of its small size and great holding strength the new Toggle Clamp should be ideally adapted to aircraft work.—AVIATION, *December, 1941.*

G-E Bearing Mandrel Cassette

A fast accurate method for radiographically inspecting cylindrical aircraft engine bearings is provided by the new G-E Bearing Mandrel Cassette made by *General Electric X-Ray Corp.*, 2012 Jackson Blvd., Chicago, Ill. Total inspection time required to x-ray 20 bearings is reduced to about 10 minutes. Unit has four 19-in. mandrels, each having capacity of four or more bearings depending on length of bearing examined. A full length film is wrapped around mandrel and is then covered with black celluloid for protection. When placed in machine, the loaded mandrels are rotated 360 deg. by electric motor drive unit so that entire surface of bearing is exposed to x-radiation. Film thus gives operator full view of uniformity of internal metal content of bearing. Mandrel travel can also be arranged to be controlled automatically so full surface of bearing is x-rayed in 60 deg. sections.—AVIATION, *December, 1941.*



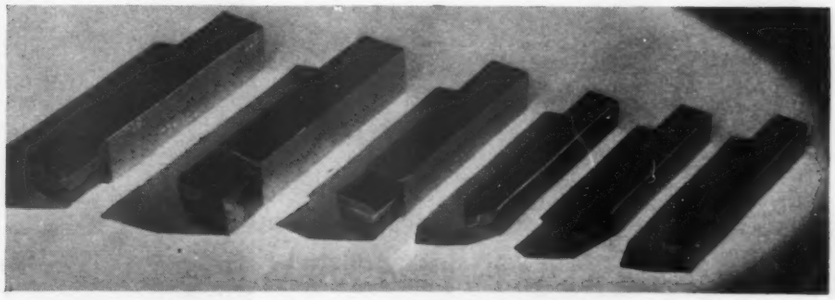
Mossman #4101 Lever Switch

A lever switch constructed to meet the need for a heavy duty, multiple contact, positive action type is offered by *Donald P. Mossman, Inc.*, 6021 N. Northwest Highway, Chicago, Ill. Designated No. 4101 Lever Switch, design affords great flexibility of contact arrangements with either locking or non-locking action. It is therefore available in an almost unlimited series of combinations of contact assemblies, which may built up to suit your specific requirements. Contact ratings for standard heavy duty contacts, $\frac{5}{16}$ in. dia. fine silver, 10 amps.—110 v., a.c. (non-inductive); extra heavy duty contacts, $\frac{1}{2}$ in. dia. Gibsiloy, 20 amps.—110 v., a.c. (non-inductive). Breakdown rating of springs to ground—2000 v., a.c. Positive action is said to be reliable and independent of the pressure of contact springs. Corrosive resistant materials or heavy plating is used throughout.—AVIATION, *December, 1941.*

Ohio Crankshaft TOCCO Jr.

The new two-station electrical induction surface hardening and heating unit which has been introduced by *Ohio Crankshaft, Inc.*, 4000 Harvard Ave., Cleveland, Ohio, is adapted to brazing, heating for forging, stress relieving and soldering as well as surface hardening. Called the Tocco Junior, it has a 20 kw. output and is able to treat small and medium size parts of an unlimited variety. The new unit is said to provide double the production capacity, with no appreciable increase in power consumption of the original one-station 20 kw. Junior, and can operate at full power capacity nearly 100 percent of the time. One operator handles both stations, preparing one fixture as other is hardening. Typical aircraft uses, among others, to which the machines have been put are brazing tubes, engine accessories and fuselage parts.—AVIATION, *December, 1941.*

Complete line of standard "stock" carbide tipped cutting tools, comprising six styles and 46 stocked sizes, are being made on a mass production basis by the *Tungsten Carbide Tool Co.*, subsidiary of Michigan Tool Co., Detroit, Mich. All tools have diamond ground edges and are ready for immediate use. Types for cast iron, steel and non-ferrous metals are included, and the tools are designed to cover the large majority of all turning, boring and facing requirements. They may be easily converted into special shapes by simple grinding operations. Styles and sizes suitable for cast iron and non-ferrous metals are furnished with grey shanks, those for steel with black.—AVIATION, *December, 1941.*



Tungsten standard cutting tools

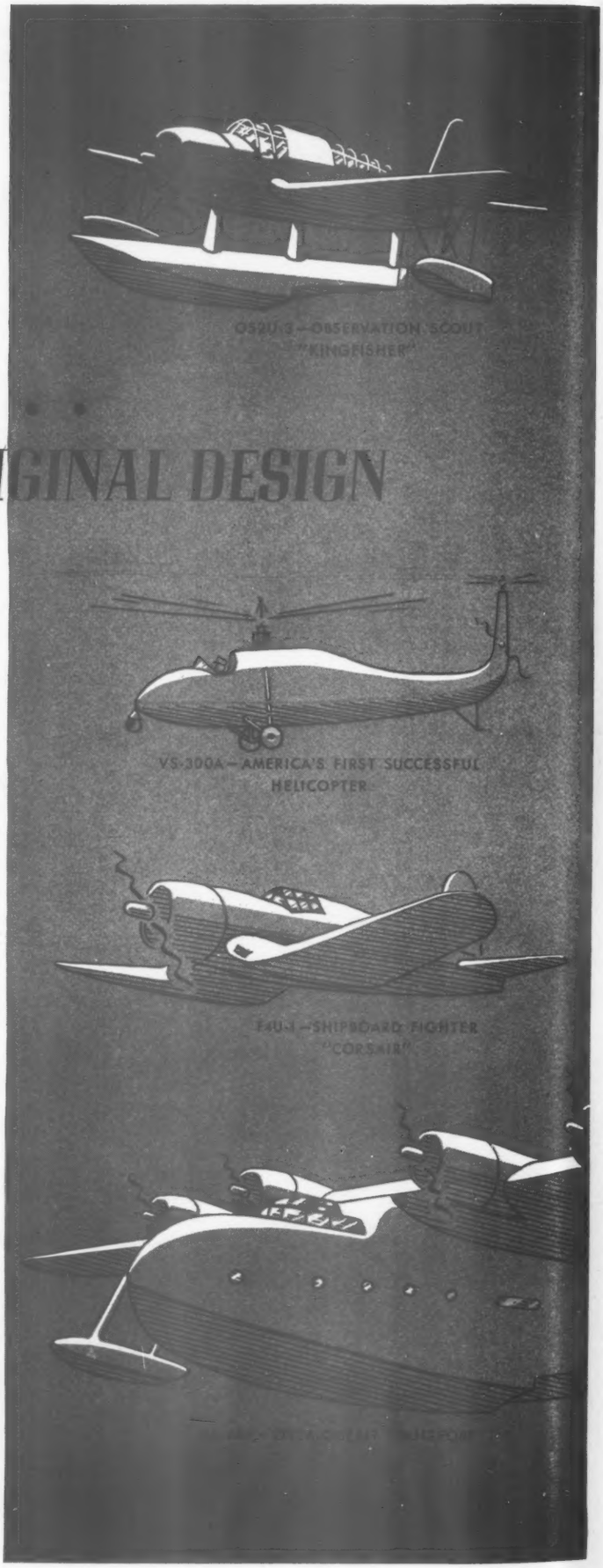
America . . .

BIRTHPLACE of ORIGINAL DESIGN

The creative genius of the aircraft industry is strikingly revealed in production activities at Vought-Sikorsky. Four distinct types of aircraft are now being built:

- ★ **The Navy's standard observation scout**
- ★ **The first successful American helicopter**
- ★ **A Navy fighter hailed as America's fastest**
- ★ **The first non-stop trans-Atlantic transport**

And on the drafting boards even more revolutionary types are being created.



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OF UNITED AIRCRAFT CORPORATION

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington | C. F. McReynolds, Pacific Coast | Randolph Hawthorne, New York | E. R. Lockin, New York

DECEMBER 1941

CAA May Expand Port Plan to $200,000,000

Plans to expand the Civil-Airport two-year program to a total of $200,000,000 have been unofficially confirmed by officials of CAA. The Authority has a request before the Budget Bureau for $67,000,000, which would be in addition to $94,978,000 existing CAA appropriations plus $40,000,000 WPA money. These latter two are intended to complete the original 250-port program started last year, and to improve 149 other fields. The $67,000,000 would provide for a program as yet not outlined.

Specifically, it is expected that any extension of the program will be held to fields approved as necessary to defense, as indicated by an interdepartmental board, representing the War, Navy, and Commerce Departments. Selection of sites, proximity to strategic defensive areas, military training bases, and strategic air routes, are obvious dominant factors in such considerations.

The board is understood to have agreed upon tentative rules which would ban construction of new airports within 6 miles of the let-down legs of a radio range or instrument landing beam, if within ten miles of a radio range station.

It is further expected that civil airports taken over for Army or Navy training activities will no longer be available for civil aviation, although fields

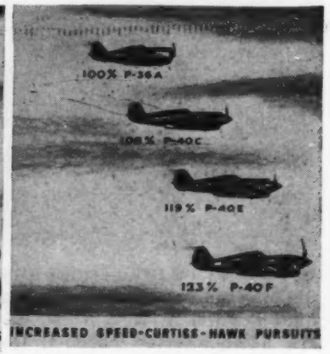
(Turn to page 141)

Acme

IN TIGHT FORMATION a squadron of Glenn Martin "Maryland" bombers flown by the South African Air Force speeds on its mission to raid enemy harbors in North Africa.

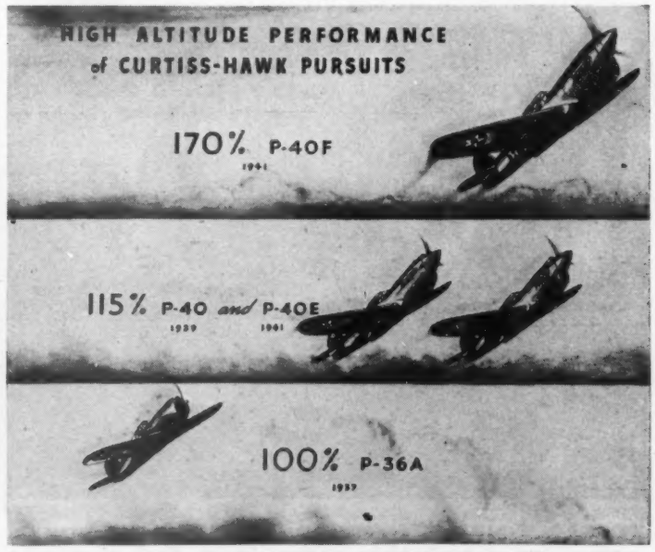
PART of the largest mass flight delivery of airplanes on record. On October 18, 123 Vultee Valiant basic trainers took off at 11-second intervals from Vultee Field, Calif., with Army and Navy pilots aboard. They are equipped with Pratt & Whitney engines and Hamilton Standard propellers.

STRIKING POWER-CURTISS-HAWK PURSUITS



INCREASED SPEED-CURTISS-HAWK PURSUITS

CURTISS-WRIGHT has been stepping up performance of its P-40 series. Drawing above at left shows fire-power of the P-40 F which has a 1150 hp. Rolls-Royce engine built by Packard. It is estimated that this late model has either five or six .50 caliber machine guns in each wing. Speed of Curtiss pursuits has been increasing steadily. The P-36 had a top speed of about 325 m.p.h. Chart at right, approved by Air Corps, gives F series a speed close to 400 m.p.h.



THE CEILING of the E series was 17,000 ft. On this basis the latest model has a ceiling of 25,000 ft., which is a very real improvement in performance.

Aircraft Standards Group Holds Annual Meeting

A far greater degree of standardization between the principal aircraft manufacturers of the United States will result from the annual national meeting of standards engineers and government representatives held at the Lexington Hotel in New York, November 10-13.

The four-day meeting follows a year of group conferences held in many cities on a large number of problems, in collaboration with the standards and technical bodies of the Army, Navy and Civil Aeronautical Boards, the Office of Production Management and other authoritative groups.

The much accelerated program of aircraft construction has multiplied standards problems along with others, but the present emergency has brought a saner handling of small parts design with respect to interchangeability. Before the present war, the degree of standardization was low, and the methods were awkward and slow; but the aircraft manufacturers today are sharing standard methods and parts designs, working more directly with advancing experience. Stock sizes of raw materials are reduced in number, individual parts and sub-assemblies are made interchangeable, test data are exchanged; other companies are called into group conferences before the design is determined. The National Aircraft Standards Committee is ready on short notice to give the Government services an industry-wide survey of a problem, which was not possible before the present emergency.

These steps toward interchangeability and simplified practice are directly beneficial to raw material suppliers, subcontract and primary contract manufacturers, and promises wherever used to lower the unit cost of airplanes. Each new standard opens the way to more comprehensive standards. The greatest saving is in time.

The meeting was begun with an executive group session to revise the operations directive. The first full meeting of all representatives convened to elect new national leaders as follows:

National chairman John Cramer (Boeing), Eastern Chairman Jack Thompson (Glenn L. Martin), Western Chairman Carl Torresen (North American Aviation), Comdr. R. D. McCart (Brewster), Newton Houston (North American), and Jack Gray, National Secretary (Aeronautical Chamber of Commerce). These are the Executive Board of the Committee.

The other members are: J. J. Clark (Boeing, Wichita), William Smith (Bell), George Evans (Brewster), Gordon Waite (Consolidated), Eric Dudley (Curtiss, Buffalo), M. A. Rhoads (Curtiss, St. Louis), Henry Gunning (Douglas, Santa Monica), Frank Salisburg (Douglas, El Segundo), Robert Neill (Fleetwings), W. D. Craig, Jr. (Grumman), Dave Mendenhall (Harlow), W. H. Colcord (Kellett), Glen Aron (Northrop), Louis Cummaro (Lockheed), Joe Perina, (Republic), A. M. Stutz (Stinson), J. B. Misner (Hughes), Jack Cox (Vega), C. E. Wingate (Vought-Sikorsky), Charles Sardou, Jr. (Vultee), Tom Hearne (Ryan).

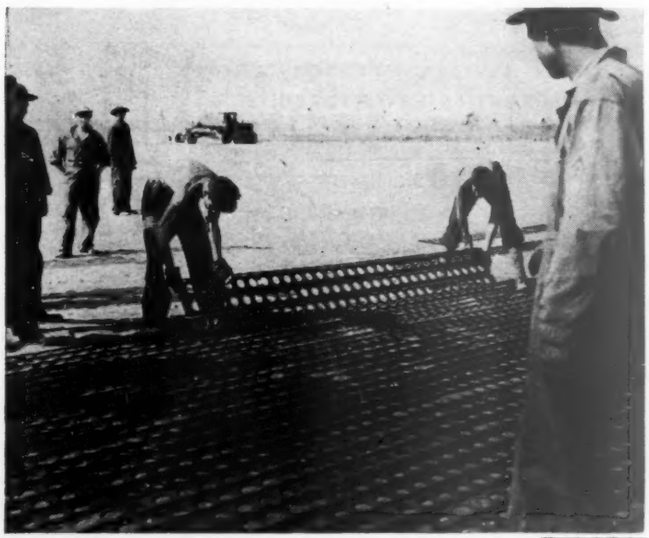
Also in attendance were Carl Stryker of the OPM, Lieut. Col. D. G. Lingle, Army Air Corps, Capt. H. M. Cronk, Army Air Corps, Lieut Gerder, Navy.

Speaking on special subjects were Lieut. Col. D. G. Lingle, Cyril Ainsworth, Secretary of the American Standards Association, Carl Stryker and John Sanborn of the Manufacturers' Aircraft Association.

International News Photo

THIS UNUSUAL PHOTOGRAPH shows clearly details of the hoisting mechanism and guns of the forward turrets aboard the U.S.S. Lexington, 14-year-old aircraft carrier which turned in a good 32 knots during recent speed trials in the Pacific.

OFFICERS AND MEMBERS of the National Aircraft Standards Committee at their annual meeting held at the Lexington Hotel in New York, November 10-13. Seated, l. to r., are newly elected national leaders: Western Chairman Carl Torresen (North American Aviation); National Chairman John Cramer (Boeing); Eastern Chairman Jack Thompson (Glenn L. Martin); and Jack Gray, National Secretary (Aeronautical Chamber of Commerce). Two additional members of the Executive Board, Comdr. R. D. McCart (Brewster) and Newton Houston (North American) got away before the photographer arrived.



Harris & Ewing

PORTABLE AIRPORTS are the newest thing in the Army engineers' bag of mechanized warfare tricks. Each strip locks into the other to form a metal mat runway 3,000 ft. long by 150 ft. wide. Holes in strips allow grass to grow through and camouflage it.

Air Support Command

Maj. Gen. Herbert A. Dargue, commanding the First Air Force, announces establishment of the First Air Support Command to support the Army's ground units.

It will be one of five ASCs which will operate with the First, Second, Third, and Fourth Field Armies, and with the Armored Force.

Col. William E. Kepner is in command of the new First Support Command, which has its headquarters at Mitchell Field, N. Y.

The air support command combines lighter and heavier-than-air, light bombers, dive bombers, photo planes, gliders,

and transports for 'chute troops —all the aviation elements a ground force needs to achieve local air superiority.

To the First has been assigned, initially, three observation groups, a bombardment group, three tow target detachments, a balloon squadron, and a signal company, all based in the East—New England to the Carolinas.

Airport Protection

Municipal employes throughout the country will be trained by the Cooper Union in airport protection, including the study of explosive bombs and their effect on hangars, runways and airline service, at the request of Mayor LaGuardia, director of Civilian Defense.

Paul H. Robbins, civil engineering instructor at Cooper Union will direct a series of two-week training courses in New York during December and January for representatives of cities all over the country. These will be schooled as instructors for their own communities.

Two-Control Licensing

Proposed regulations for the licensing of pilots to fly light planes operating on the two-control principle have been circulated to the industry by the CAB for comment.

It is proposed that the spin test be eliminated so that special private licenses limited to this type of aircraft can be issued, since these planes are rated as characteristically incapable of spinning, thereby making it possible for a pilot to be certificated after 5 hours of dual and 25 of solo instead of the required 8 hours dual and 30 solo for regular private licenses.

With such a license, a pilot could take his spin test later and receive a regular private pilot's certificate. Thus far, the only two planes so produced are the Ercoupe and the Skyfarer.

CAA Airport Plan

(*Continued from page 139*)

occupied by Air Corps tactical units may be used jointly for scheduled commercial traffic, but not for unscheduled flights by planes lacking 2-way radio.

As viewed in some quarters, this prospect leaves many areas that probably will not benefit from the proposed CAA program, and in consequence, a continuing need for construction of fields suitable for private planes and emergency landing by other aircraft.

SPOT CHECKING

Washington to Alaska direct service will be established if application of Northwest Airlines for two routes: Washington-Chicago and Minneapolis-Fairbanks is granted. Route would cut 700 miles off trip from East via Seattle on Pan American. Maybe Administration wants it, for defense reasons; if so, question of equipment would be hurdled.

Culver Aircraft Corporation has passed to control of Walter H. Beech and Charles G. Yankee. Beech organized Travelaire and is now president of Beech Aircraft. Yankee is vice president of Beech.

Glenn Martin Company launched the 80-ton XPB2M1 down a way, like a ship, with speeches and band music. Chief Engineer W. K. Ebel said motors had been run, wings flexed. Tests will show ship's "finesse and habits." He said more of the type would be built for Navy.

Credit for 30 hours CPT flying time is now given by the Army, as it has been by Navy since last winter.

Flight strips, to supplement existing airports, will be built with $10,000,000 included in a highway authorization bill on its way to the President as this was written. Work will begin when appropriation is made.

Capetown Clipper, newest of the Boeing 314s, with all the design improvements made on the others; 5400 gallons gas capacity; 2000 pounds more than original pay load; four 1650 h.p. Wright Cyclones totaling 6600 h.p.—took off on a survey of the three-continent Miami-Nata-Leopoldville African line. She carried crew of 14 and PAA and CAA officials. Total course mileage: 9253.

Aeronautical shipments to Britain from January to August totalled $330,000,000, or an average of $40,000,000 a month. A little over $6,000,000 of this was under Lend-Lease, while the rest was applied against the roughly $2,000,000,000 in orders placed by the British prior to Lease-Lend.

North American is now employing more than 14,500 men at Inglewood—9200 on the first shift, 5,200 on the second, and some 130 on the third. At Dallas, more than 5,300—about 3,500 on first shift, about 1,800 on the second, and about 35 on the third.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Second Hand Parts

The story goes that since war started, the Turks, who have German-made planes, have not been able to get parts. So the British shoot down Germans over England and send the parts to the Turks. This makes a nifty bit of reading, and it indicates that the British do not expect the Turks to line up with the Nazis.

If the day ever comes when the British and the Russians appear to be beaten, and the United States must decide whether to shut off the flow of airplanes and munitions to them, so as to arm ourselves for battle, it will be one of the most momentous decisions in history. Although some Army officers are griping, now, about the number of planes going to Russia, the betting is better than even that the day of decision will not come.

Twenty minutes delay in delivery of baggage to incoming passengers at Washington National Airport was the complaint of some callers at our office the other day. "They routed the bags all over in trucks and elevators and red-tape," said the travelers. "Why don't they just give us our bags?" Well, why don't they? Architectural Forum (magazine) reviewing the National Airport, says it is too much architecture and not enough simple function—makes that complaint against air terminal design in general. The Forum's idea of car-to-plane stations along loading line, omitting "grand central" business, would be practical.

Army seems determined to keep women out of any combat and clear beyond the smell of burning powder. Maj. Gen. H. H. Arnold, Deputy Chief of Staff for Air, says Army has decided not to let women ferry bombers from factory to flying field. He said he didn't want to "complicate matters." One real reason is that when so few men are physically constituted to fly hot war planes, it follows that a negligible number of women are so constituted.

A man is touring the Far East and the Mediterranean for Army Air Forces, and he will make a report before long, which you will not read till some Generals publish their memoirs, maybe ten years from now.

The French liner Normandie, now interned in New York, probably will be stripped of stacks and topside and turned into an air-craft carrier. It will be nearly three times as big as any carrier in the world. 83,000 tons, against 33,000 for the Lexington and Saratoga, and it will be the fastest. The Normandie was built with just that in mind; its stacks come up the side and over to the center, and the elevators are grouped for conversion into an aircraft lift.

Colored sparks will fly in Congress if any of the dozen or so bills proposing a separate air force, or a unified aviation system, ever get to the point of hearings. There will be rivers of conversation by people who don't know what they are talking about, and a small stream by people who do. There will be name-calling and double talk, and a thick, expensive transcript of it all, and, in the opinion of most on-lookers, nothing else will happen.

The Stubblefield award goes to the Army for taking the airport directory out of circulation. Army pilots and several thousand government officials can have it, but air mail pilots and the rest of us can't. It's a secret. The idea is to keep the Nazis from getting the directory—in less than two hours.

Army Air Forces Are Expanded to 84 Groups 400,000 Personnel, Probably 50,000 Planes

Washington (AVIATION Bureau)—Regardless of the war's outcome overseas, the United States Army will take on any and all comers to this hemisphere. To that end, the "54-Group Program" of the Army Air Forces is being expanded to 84 Combat groups.

This involves an increase in non-commissioned strength to 400,000 cadets and enlisted men by June 30 next summer, with subsequent expansion to 500,000. As late as June 1940, Air Corps personnel totaled only 3322 officers, 1894 cadets, and 45,914 enlisted men. On June 30, 1941, those figures respectively were 10,697, 8707, and 126,666. Growth of this country's air power will be a phenomenon in military history.

Of course the 84-Combat Group cannot have its quota of airplanes as long as Britain, Russia, China, Dutch East Indies, need our production more than we do. But, should those powers fail to stop the Axis, and if Axis powers tried to poach on this side of the world, our aircraft plants could pour equipment into the Army at a rate no other power could match.

But delayed equipment does not mean that the 84-Group Program is just a paper project. The Air Forces have on hand, and will meantime acquire, enough training equipment of all kinds—primary, advance, and tactical, to make the fully-manned air arm ready to take off for a fight upon delivery of its quota of airplanes.

It is not announced how many airplanes the expanded air arm will use. The 54-Group program called for about 12,500 with as many reserves, or a total of 25,000. Congress has made appropriations for about 46,000 planes for the Army. You can guess, on the basis of that and the President's original plan, that the Air Forces are aiming at about 50,000. That would be far and away the biggest aviation power in the world.

This forehanded planning and leadership, generally regarded as worthy of the confidence and tax money of the people, is guided by Major General Henry H. Arnold, Chief of the Army Air Forces and Deputy Chief of Staff for Air; Major General George H. Brett, Chief of the Air Corps; and Lieut. General Delos Emmons, Commanding General, Combat Command.

The new tactical Groups will be assigned to the Combat Command for operational training, while the Air Corps will continue in charge of the individual training of pilots and technicians. The Air Corps will continue its duties in training, ferrying, personnel, intelligence, materiél buildings and grounds.

The old 54-Group program which called for expansion to 16,800 officers, 187,000 enlisted men, and 15,000 cadets, will be gradually merged with the new 84-Group plan, calling for 400,000 to 500,000 cadets and enlisted men. The new flight personnel quota is not mentioned, for military reasons. It will be recalled that the objective of 12,000 pilots (and 48,000 technicians) was increased to 30,000 pilots and 100,000 technicians prior to promulgation of the new 84-group program.

Under the 30,000 pilots per year schedule three Air Corps Training Centers (Southeast, Gulf, and West Coast) supervise the activities of 41 civilian schools giving 10 weeks of elementary training; 15 military basic flying schools and 3 civilian schools giving basic training; and 21 advanced military flight training schools, 7 of which are single-engine flying schools and 14 two-engine flying schools. There are 3 flexible gunnery military schools, 1 civil navigation school, and 3 replacement training centers (pilot, bombardier, and navigator). There are 3 navigator schools and 6 bombardier schools. Technical training of enlisted specialists is conducted in 19 other schools and 3 replacement training centers.

On December 18, 1940, four Air District Headquarters were formed, together with 14 additional Wing Headquarters, to provide the overhead to care for the assignment of all personnel and planes in the 54-Group Program. The Air Districts, which were a geographical setup, have been redesignated as the First, Second, Third, and Fourth Air Forces.

This was followed on June 22, 1941, by unification of air activities under the present "autonomous" organization, the Army Air Forces. A number of the 84 Combat Groups to be created as the goal of the new program will be assigned to overseas departments.

The greater number, however, will be assigned to the Air Force Combat Command, which is the fighting force of the Army Air Forces and is composed of Bombardment Aviation (Heavy, Medium and Light), Pursuit Aviation (Interceptor and Fighter), and Reconnaisance Aviation (Medium and Long Range), operating either alone or in support of the ground and naval forces. Certain other aviation, such as Observation and Liaison, also a part of the A.F.C.C., is usually assigned for use by the ground forces.

Aviation components of the Hawaiian and Panama Canal Departments will be organized into Department Air Forces under their respective Department Commanders, to attain the unity of command so essential for successful operations.

Wide World

ARMY AIR CORPS' NEWEST and largest air mechanics training school, Sheppard Field, Wichita Falls, Texas, where 26,000 men will be in service.

AAF Accidents Increase in Early Combat Stage But Decrease in Primary, Basic and Advance

Washington (AVIATION Bureau)—Multiple accidents in the Army Air Force recently have caused intensified public concern and have brought insistent requests from the press for statistics on training hours and rate of accidents to pilot hours in all training categories.

As this was written, AAF officials were considering whether the release of such information would be in the public interest.

The War Department did, however, issue a statement explaining that, "Despite the greatly increased amount of training and tactical flying now being done . . . and the use of new airplanes of much higher speeds and performance, the accident rate in military flying during the past fiscal year has remained substantially unchanged."

Whether or not this statement would hold entirely true under the increased number of accidents this autumn, was not revealed.

The Air Force some time ago

(*Turn to page* 145)

BEECH AT-11, twin engine advanced trainer delivered to the Air Corps for specialized training of bombardiers and gunners. Equipped with flexible guns and bomb racks for instruction of crews, it is powered by Pratt & Whitney 450 hp. engines.

NO. 9

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FIVE OF THESE PLANTS will smelt aluminum. Their combined capacity is planned for more than 500,000,000 pounds a year, which is greater than the nation's entire production of aluminum in 1940. Locations: Massena, N. Y., Spokane, Wash., Troutdale, Ore., Los Angeles, and in the State of Arkansas.

The sixth plant will refine alumina from bauxite. Its billion-pounds-a-year capacity adds 58% to the nation's alumina capacity. It will be located at Bauxite, Arkansas.

HOW GOES CONSTRUCTION? At this writing, as fast as title is secured to the sites, contracts are being let for grading and foundations so as to be ready for the structural steel, which is coming as rapidly as it can be gotten.

What is more important, the aluminum plants are scheduled to deliver ingot by the summer of 1942; the refining plant to deliver alumina in early summer, 1942.

WE'VE ASSIGNED a large staff of men full time to headquarters engineering, purchasing, and accounting on this government building job.

We're sending competent and experienced management men out on these jobs as superintendents and other staff executives on construction, and for subsequent operation of such of these plants as we are designated to operate.

EVERY KNOWN IMPROVEMENT in design and construction and equipment is being incorporated in these plants. We intend that every dollar that will be spent shall be the best dollar's worth that experience can build. We do not make one cent of profit from this assigned job of construction.

We think we know how to get the government value-received for its money, because we are completing the expenditure of more than $200,000,000 of our own money in an expansion program which started after the beginning of the present war. Some of this expenditure is in new alumina and aluminum plants which will bring our own Alcoa capacity up to more than 700,000,000 pounds a year. The remainder is in tremendous expansion of facilities for fabricating every form of aluminum.

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Add up the three big important requisites in a trainer for profitable CPTP Operation—Ease of Maintenance—Sturdy Construction—Superior Performance —and you have the blue and yellow Interstate Cadet.

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AAF Accidents

(Continued from page 142)

cut the requirement of 2000 hours and ten years of experience for principal pilot on four-engined equipment, to 750 hours and two years of experience. It is assumed that comparable cuts must have been made in other categories of training and technical work. Students are going out of advance training into combat squadrons with 200 hours in some cases, and with an average of 210 hours.

In its formal statement, the War Department said that although the number of miles flown by Army pilots and students has increased and is still increasing in almost "astronomical" proportions, the number of fatal accidents per mile flown continue practically unchanged in virtually every phase of military aviation.

The accident rate in primary training during the past fiscal year was slightly below the average rate for the three-year pre-emergency period. In basic training, the accident rate was below the three-year mean and also below the 1940 rate. The same was true of advanced training.

The slight increase in combat squadron accidents was expected, the statement says, what with 200-hour students coming in, into combat, and using high-performance equipment. But this rate will go down as they gain experience.

Despite influx of new and faster airplanes, the accident rate among the older pilots has gone down below the three-year level.

Considering that the Air Force is now on a semi-wartime basis, carrying out missions essential to realistic combat training, the Army feels that it is doing pretty well. Safety is given every possible consideration in the circumstances.

Unofficial comment on the recent series of accidents is that men of relatively small experience—mere tyros compared with the titans of the airmail—are running into winter weather and other conditions they are not able to cope with.

European Front Reports

RAF squadrons are calling the Bell Airacobra "The best pursuit plane in the air . . . Better than anything we or the Germans have in operation," according to United Press dispatch. Some pilots told UP that RAF had removed the 37 mm. cannon from the Airacobra and replaced it with 20 mm. gun because they wanted faster shooting and more rounds of ammunition. Whether this change has been general is not told.

Wide World

"VEST POCKET" RATIONS for paratroops. This one-day supply of concentrated food weighs but 32.8 oz., contains 3,726 calories.

Shell guns on airplanes are proving extremely destructive, to enemy planes and to ground objectives. They penetrate the boilers of railroad locomotives and ships, putting them out of business. They've been knocking out "invasion" barges, too.

Two thirds of the American Eagle Squadron in England learned to fly in the CPTP, according to a report from Harold Strickland, a Chicagoan now with AES in London, to the Civil Aeronautics Authority. Boys who first hopped in a Cub 12 months ago are now hitting the Jerries.

A Martin B-10 bomber of the Netherlands Army was forced down in the Java Sea, floated for an unstated time until rescue planes arrived. Martin officials long have claimed that this airplane would float at least 48 hours.

Early in November, the Russians transported "several divisions" of ski troops from the Ural Mountains up to the Moscow front. A division might be 10,000 to 25,000 men. Thus the Russians may have air-borne what amounts to an army. Armies may some day move in the air, as the Marines now move on water, and strategists everywhere are thinking about the possibility.

A Bristol Blenheim, making a low-level attack on a Nazi convoy off Holland, was hit in the starboard engine by a shell. The plane hit the water, dipped its propellers, but, almost incredibly, stayed in the air and, after smacking the water once more, got home, "making some remarkable noises."

The "Hurricane II" is armed with 12 machine guns or four 20 mm. cannon, the most heavily gunned fighter in service. It has a two-speed supercharger which is said to give it a higher ceiling than the eight-gun Hurricane I, a better rate of climb at high levels, and better top speed. The Messerschmitt 109F, newest version, has one 15 mm. cannon and two machine guns. The cannon, however, fires at rate of 900 rounds per minute.

The British "Beaufighter," a twin-engined fighting ship, has four cannon, presumably 20 mm. size, and six machine guns, probably including some 50 caliber.

Society of British Aircraft Constructors says that German airplane manufacture is now extended to its limit, but they admit they do not know what reserves the Germans have on hand. SBAC says its own construction program will soon turn the Battle of Britain into the Battle of Germany. A recent census shows that about 30 percent of all the British aircraft workers are women.

The Russians are showing up with hundreds of a new bomber of the YAK-4 type, said by the British to be extremely fast and devastating. Persons who watch reports on Nazi-Russ air action observe that claims of planes destroyed on both sides are now sometimes only 10 or 15 a day, as against previous bags of over a hundred a day. They wonder whether both sides' air forces are so badly depleted that few planes are engaged. This seems improbable.

Conflicting with reports of more and more speed in fighting planes on the front, are other reports of a tendency to sacrifice speed for other advantages. Certain it is that human endurance of blackout and pressure on internal organs due to turns and pull-outs has about reached its limit, unless the flight medicos find some remedy.

Round World Record & Longest Overwater Hop

A new round-the-world flight time record was set, and the longest over-water hop was made, by Maj. Alva L. Harvey, commanding a four-motored Consolidated B-24 bomber leaving Washington, D. C., at 7:30 a.m. Sept. 13 and flying East to Washington again.

The trip took members of the Harriman mission to Moscow for a war council. The 18-ton ship made the 24,700-mile run in less time than any other airplane has made it. The itinerary was Gander Lake, Newfoundland; Archangel, Russia; Moscow; Singapore; Darwin, Australia; Wake Island; Honolulu; Los Angeles; Washington. The longest water jump, by a land plane was Singapore to Los Angeles.

Contrary to reports, the Air Force tells this writer that the Harvey trip was not attacked at any point.

This trip should not be confused with the 26,000-mile flight in a B-24 to the Near East and Egypt, by Lt. Col. Caleb V. Haynes, carrying Maj. George H. Brett, Chief of the Air Corps, and his party. His speed averaged 237 m.p.h.

Four BBB's Organized

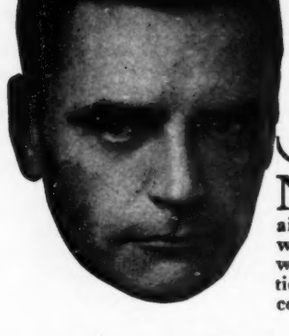
Four additional Coast Artillery Barrage Balloon Battalions are organized at Camp Davis, North Carolina. Each new battalion has an authorized strength of 1,257 soldiers and is assigned to the Barrage Balloon Training center at Camp Davis.

Initial strength of the 302d, 303d, and 304th Coast Artillery Barrage Balloon Battalions will be 200 enlisted men. The 305th Battalion will be formed without Battery C and will have an initial strength of 150 enlisted men.

Officers for the new battalions will be supplied by the War Department from the group now on duty at the Barrage Balloon Training Center.

Radio Procurement

A Signal Corps Procurement District at Wright Field, Dayton, is established to speed up production and delivery of aircraft radio equipment, the War Department announces.



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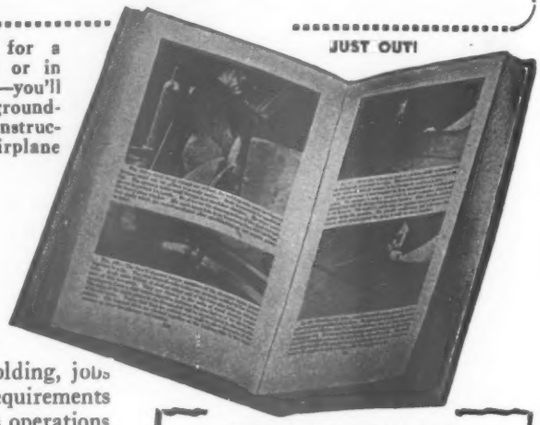

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"Victory Program" Production Expansion Won't Change Deliveries Before 1943

Washington (AVIATION Bureau): Tall tales of doubling up the aircraft production schedules have some foundation in fact, but they can be mighty misleading when the time factor is left out. Big increases in capacity are in the making, but they won't have any substantial effect on actual deliveries until the latter half of 1943.

Much confusion has been created because tank production figures were the first of the "Victory program" schedules to leak out. These involve real and startling increases over original plans, and it was a natural assumption that other types of armament were being stepped up in proportion. People forgot that until this summer tanks were the step-children of defense. They weren't thought important; they had low priorities; tools were constantly snatched away from the tank arsenals. So it's easy now to speed the tanks merely by putting them at the top of the waiting list on tools and materials.

Planes are another matter. The schedules laid down a year ago were based on what was considered the maximum possible. Then last spring, these schedules were stretched to include a larger amount of heavy stuff. They are now considered as crowding the limits of physical capacity, and no one has any idea that they can be increased much.

Present schedules, however, are designed to flatten out in July, 1943, at a constant production rate of about 4,000 planes a month (50,000 a year). What is now in the works is a plan to have production keep right on climbing rather than level off.

How fast and how far production will climb in late 1943 and 1944 is still anybody's guess. It's a technical question. What's involved is the manpower and material tonnage that can be found and, even more significant, how much production skill can be diverted to planning and tooling for 1944 airplanes without interfering with deliveries of planes in 1942. OPM technicians are now trying to work out the answer.

In terms of numbers of planes, the increase probably won't be startling, since it will be concentrated in heavy equipment—bombers half again or more as big as present four-engine equipment. There may even be temporary reductions in total number of planes resulting from conversion of facilities for production of light types to work on the big ships—a process which is already underway as part of the bomber program.

For the visible future, then, the production situation shapes up about as follows: Production will substantially better 2,500 by the end of this year, reach something between 3,000 and 3,500 by next July. This includes a level production of some 900 trainers a month, which will begin to taper off after July. Thereafter, total output will rise rather slowly to something a little over 4,000 in July 1943. That 4,000 will include about 500 heavy bombers and perhaps 4,500 trainers.

Meanwhile, work must start within the next few months on provision of facilities for the added production in 1943. At best it takes 12 to 18 months to get new plants into production, and on this program it will probably take longer. The tank program and a number of ordnance programs will have first call on available tools and materials. Further plant expansion is going to be a slow job.

Aeronca Expands Plant

Construction is underway on an extension to Aeronca Aircraft Corporation's Middletown, O., plant which will add 30,000 square feet of factory space. The new addition will relieve congestion in the main factory and provide space to step-up production to 2,750 planes per year, according to the company's announcement.

Manufacturers' Priorities Being Changed to New Basis

Washington (AVIATION Bureau): Although the blanket ratings granted to builders of planes, engines, and props have been extended to the end of the year, studies are now underway to develop a new method of giving preference to purchases by manufacturers. The present blanket orders, assigned last April, give a rating of A-1-d to purchases by plane builders and A-1-c to orders placed by manufacturers of engines and propellers.

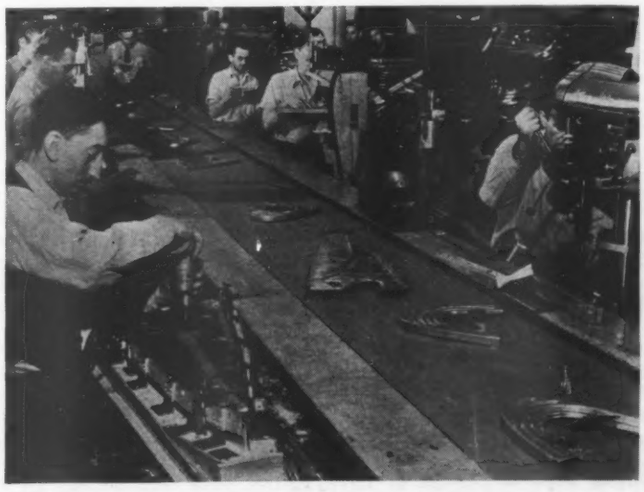
For next year, two types of changes are contemplated. Most of the bulk items bought by manufacturers will be subject to allocation, and a more restricted type of blanket rating will be used for other purchases.

Objective in changing the form of the blanket priority rating is to avoid some abuses which have developed; in some cases manufacturers have built up excessive inventories and in others they have used the ratings for unessential purchases. One classic case involved attachment of an A-1-d rating to an order for six copies of "How to Win Friends and Influence People;" this didn't win many friends for the company involved.

Most probable change will limit use of the rating to deliveries scheduled over the next ninety days. Manufacturers will still be encouraged to place orders as far ahead as possible, but they won't carry a rating until three months before delivery date. Some thought was given to restricting extension of the rating past the first supplier to goods which will be physically incorporated in the aircraft, but it appears now that this would raise too many difficulties in an industry expanding as fast as aircraft is.

In aircraft, as in other defense industries, allocation of goods is due to assume an ever-increasing importance. This simply means that OPM, without bothering with ratings, tells suppliers to make certain deliveries to certain firms. Aluminum has been on this basis for a long time, and an effort is now underway to work out similar arrangements for steel used in aircraft.

Plan is to have each company submit estimates of its 1942 needs. Then these estimates, which total only a few thousand tons, would be pooled and the work divided up among the steel companies. The steel would be run through early in the year in large lots—thus economizing on the use of steel mill facilities. Difficulty, of course, is to get estimates of needs that will stand up for a whole year. Wrong estimates might cause serious trouble toward the end of 1942. Moreover, some companies don't like the idea of having their orders for specialized products such as forgings and extrusions lumped into a pool; they would rather continue dealing with their regular suppliers.



BELT-CONVEYOR LINE mass production technique adopted at Glenn L. Martin Co. has reduced by half man-hours required on certain subassemblies. Each man along the line performs one type of machine or hand operation, attaining greater accuracy and higher speed. The system is to be widely used.

Bigger Third Shifts Sought by OPM

Defense officials are deeply disturbed by the failure of defense industry in general to go onto full three-shift operations. Although most aircraft plants technically maintain three shifts, most second shifts are considered much too small in relation to the size of the first shift, and the adequate third shift is a rare exception.

A survey made about a month ago showed that only one firm in the industry had as many as 17 percent of its employees working the third shift. The

biggest second shift found among major companies comprised 40 percent of payroll. Administration officials recognize the difficulties of labor shortage and plant balance involved in full three-shift operation, but they think aggressive management effort ought to be able to get around them.

Utilization of tools in defense factories at present averages about 50 hours a week, and the administration would like to push this up to 100 hours. The President's speech last month asking longer hours was one gun in the campaign. In another move, conferences are being held with individual firms at which they are confronted with the figures on their tool utilization and challenged to explain why they aren't doing better.

Aircraft Service Association

Formed to coordinate aircraft maintenance and service work of the major manufacturers, the "Aircraft Manufacturers Service Association" has been organized in Southern California. Charter members of the new group are: Lockheed, Douglas, North American Aviation, Harlow, Hughes, Ryan, Vega, Vultee, and Northrop aircraft companies, together with B. G. Corp., Bendix, Pacific Airmotive, Menasco, Pratt & Whitney, and Wright Aeronautical Corp.

Officers elected at the first meeting were: Reagan C. Stunkel, Lockheed, Pres.; Otto Graff, Vega, vice-pres.; James B. Thompson, Vultee, secty.; Thomas Bond, North American, treas.; and Don Sprague, Douglas; Eddie Cooper, Bendix; and James Misner, Hughes Aircraft; were elected committee-men at large.

Assembly Lines

by Robert Colborn

Censorship has clamped down tight on aircraft production figures of all sorts. Not only are monthly production figures under the ban, but information on floorspace, employees, payrolls and the like are now secret. Commerce Department will no longer report exports of aircraft.

Inspiration for the new policy comes from the War Department. It is opposed in OPM and the industry. Efforts are being made to find some indicator of progress—percent of schedule, poundage, dollar value, or the like—which will satisfy the military. This has been unsuccessful so far, and indications are that rigid secrecy will be the rule for some time to come.

International News

SIX OF BRITAIN'S experienced wartime flyers who are now in U. S. to instruct Army pilots in split-second tactics of modern aerial combat. L. to R. (rear): Wing Commander Adolph Malan, Group Captain Harry Broadhurst, Wing Commander Roland S. S. Tuck. (front): Wing Commander John Haworth Whitworth, Group Captain John N. Boothman, Wing Commander H. Idwal Edwards.

October production is the first to go behind the veil. Late that month, Chairman Snyder of the House military affairs committee estimated that October output might reach some 2,200. It is understood that this expectation was comfortably exceeded.

Combat plane production is getting all the benefit of the recent increases in recent months, while trainer output bumps along between 800 and 900 units a month. Twice as many tactical aircraft were built in October, it is believed, as in July. About six times as many were built as in last December. Indications are that rate of output of tactical planes at the end of this year will be nearly eight times that at the end of 1940.

Export figures for August—the last official ones that will be available—show that 533 planes were shipped abroad. Most of these were bombers. Beginings of shipments to Russia probably boosted the figure to 700 in September, and October exports may well have broken a thousand.

Engine exports jumped to 1,071 units in August from less than 500 in July—reflecting the extent to which engine makers are now keeping a comfortable lead over plane production. Bulk of these engines went to Britain as spares for planes previously shipped. A considerable backlog of spares had been built up by August. A large chunk, however, went to China for installation in planes built there.

Chinese are building Curtiss P-36 pursuits and Martin 167 light bombers plus several Russian designs using U. S. engines.

Navy, according to Congressional sources, had 4,124 planes on hand in September, including trainers but exclusive of obsolete and experimental equipment.

Substantial new orders are reported by Randolph C. Walker, president of Aircraft Accessories Corp. A total of $500,000 is involved in an order for 62 complete radio range stations for the CAA, and an order amounting to $135,000 covers 30 radio transmitters for Pan American Grace Airways. Shipments during the third quarter of the year totalled $798,927 as compared with $191,129 in the same period of 1940. Directors have declared a 27 cent dividend payable Dec. 1 to stock of record Nov. 17th.

Mars is an easier name to remember than XPB2M-1, and that's what the Navy now calls the 68-ton flying boat Martin has built for it. A few more figures have been let out on it: Power plant is four Wright Cyclone Duplex engines of 2,000 hp. each. The three-bladed propellors, 17.6 ft. in diameter, are said to be the largest ever installed on an airplane. Mars will carry a collapsible motor boat aboard and its hull draws five feet of water.

Specifications on the latest flying fortress, the B-17E, are as usual available in England in somewhat more detail than here. According to *The Aeroplane* it mounts three powered gun turrets, weighs 30 tons (as compared with 25 for the B-17-D), cruises at 35,000 ft. elevation, has top speed better than 300 m.p.h. and costs about $300,000.

Twin-engined trainers are getting increasingly important as the percentage of multi-engine combat equipment on the production schedules increases. One of the biggest is Beech's new AT-11 designed for training bombardiers and gunners. Mounting two nine-cylinder 450-hp. P & W engines, it carries guns and bomb racks, can be used for training crews of three or four. It has a 47 ft. span, 35 ft. length, twin tail, retractable wheels.

Bomber pilots are to be trained in the Curtiss AT-9, now undergoing service test. This, like the AT-11, is an all metal low-wing monoplane, but it's a smaller ship powered by two 280 hp. engines. It weighs over 5,000 lb., has a 40 ft. wing span. The ship is designed to have the flying characteristics of a bigger one and has a rather complete complement of instruments.

Repair parts for any registered and certificated civil airplane may now be bought under an A-10 priority rating. This applies whether the order is placed by the owner or a dealer.

A ski for light planes made of 15-ply plastic-bonded birch plywood has been developed by the Heath Co. of Benton Harbor, Mich.

Second Eastern light plane exhibition will be held in Grand Central Palace, New York City, Feb. 21-March 1.

Solar Aircraft Company, San Diego, has acquired 30,000 additional sq. ft. of floor space and will employ 400 more men on exhaust manifold manufacturing operations by Jan. 1, 1942, according to E. T. Price, pres.

Alclad, as a name for a type of aluminum, has been released by the Aluminum Co. In future any concern making aluminum with a strong alloy core and a pure aluminum surface can call it Alclad. Hitherto the name has been exclusive property of the Aluminum Co. of America.

Republic delivered more planes to the Air Corps in October than in the entire first six months of the year. This probably means something between 50 and 100 P-43 "Lancer" radial-engine pursuits. Production of P-43s is now carried on in the newly-completed 500,000 sq. ft. plant. Early next year, when 2,000 hp. P & W engines become available, this plant will be re-tooled for the more advanced P-47 "Thunderbolt" fighter. Available engines of this size are now going into Martin's B-26 medium bomber. The present Lancer uses an engine of about 1,200 hp.

Consolidated is now delivering about $18,000,000 worth of planes a month, hopes to triple that figure by July, 1942. In the first ten years of its existence, Consolidated also delivered about $18,000,000 worth of planes. Since 1924, the company has built something over 2,300 planes with a total value of $140,000,000.

Recent Awards

War Department

Elgin National Watch Co., Elgin, Ill., $172,080 for aircraft clocks.

Curtiss-Wright Corp., Caldwell, N. J., $231,476 for propeller assemblies and parts.

Wright Aeronautical Corp., Paterson, N. J., $149,346 for tools for engines.

Sparks Withington Co., Jackson, Mich., $233,851 for airplane equipment.

Weaver Mfg. Co., Springfield, Ill., $261,750 for portable engine hoists.

Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $37,534,980 for gyroscopic instruments.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., $628,320 for pressure gages.

Firestone Tire & Rubber Co., Akron, Ohio, $830,729 for oxygen cylinders.

Aeroproducts Div. of General Motors, Dayton, Ohio, $106,900 for hub and spinner assys.

Hickok Electrical Instrument Co., Cleveland, Ohio, $335,351 for thermometer indicators.

Platt-LaPage Aircraft Co., Eddystone, Penna., $144,662 for plane equipment.

Sparks-Withington Co., Jackson, Mich., $262,368 for mooring kits.

Lewis Engineering Co., Naugatuck, Conn., $235,780 for thermometer indicators.

Oneida, Ltd., Oneida, N. Y., $200,626 for bomb shackle assys.

P. R. Mallory & Co., Inc., Indianapolis, Ind., $225,354 for release assys.

Holtzer-Cabot Electric, Boston, Mass., $115,200 for inverters.

General Electric Co., Schenectady, N. Y., $477,375 for tachometer indicators.

Longines-Wittnauer Watch Co., Inc., New York City, $239,240 for clocks.

Curtiss-Wright Corp., Buffalo, N. Y., $107,434,037 for airplanes and parts.

Lockheed Aircraft Corp., Burbank, Calif., $92,277,800 for airplanes and parts.

Emerson Electric Mfg. Co., St. Louis, Mo., $20,029,362 for machine gun turrets.

Fairchild Engine & Airplane Corp., Hagerstown, Md., $4,329,908 for airplanes and parts.

Bendix Aviation Corp., Bendix, N. J., $195,422 for parts for generators.

Douglas Aircraft Co., Inc., Santa Monica, Calif., $78,264,093 for planes and parts.

Glenn L. Martin Co., Baltimore, Md., $19,007,247 for turret assemblies.

General Motors Corp., New York City, $478,774 for hardware.

Thomas A. Edison, Inc., West Orange, N. J., $248,040 for thermometer indicators.

Service Tool & Engineering Co., Dayton, Ohio, $219,932 for aircraft fittings.

Boeing Aircraft Co., Seattle, Washington, $189,217 for parts for aircraft.

Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $370,498 for maintenance parts for pilots.

General Motors Corp., Indianapolis, Ind., $124,459,170 for aeronautical engines.

Bendix Aviation Corp., Bendix, N. J., $10,753,723 for aircraft instruments.

Square D Co., Elmhurst, N. Y., $2,997,565 for instruments.

Bendix Aviation Corp., Bendix, N. J., $2,2[illegible],450 for supercharger regulator assys.

Bendix Aviation Corp., Bendix, N. J., $1,686,830 for altimeters.

Air Cruisers, Inc., Clifton, N. J., $1,047,592 for oxygen cylinders.

Chandler-Evans Corp., South Meriden, Conn., $1,320,877 for fuel pumps.

Chandler-Hill Corp., Detroit, Mich., $820,900 for fuel pumps.

Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $781,524 for automatic pilots.

J. P. Seeburg Corp., Chicago, Ill., $343,150 for control assemblies.

United Aircraft Corp., East Hartford, Conn., $478,646 for parts for engines.

Electronic Laboratories, Inc., Indianapolis, Ind., $104,760 for inverters.

Westinghouse Electric & Mfg. Co., Dayton, Ohio, $632,500 for voltage regulators.

Independent Engineering Co., Inc., O'Fallon, Ill., $829,309 for oxygen cylinders.

Crosley Corp., Cincinnati, Ohio, $661,032 for shackle assemblies.

Bendix Aviation Corp., Bendix, N. J., $779,453 for maintenance parts.

Bendix Aviation Corp., Bendix, N. J., $763,135 for starter, switch and solenoid assys.

Jack & Heintz, Inc., Cleveland, Ohio, $808,500 for starter assemblies.

Leece-Neville Co., Cleveland, Ohio, $648,587 for panel assemblies.

Crosley Corp., Cincinnati, Ohio, $501,000 for release assemblies.

Aviation Mfg. Corp., Williamsport, Penna., $776,000 for propeller blades.

Wright Aeronautical Corp., Paterson, N. J., $559,972 for maintenance parts for engines.

Ryan Aeronautical Co., San Diego, Calif., $103,000 for airplanes.

Service Tool & Eng. Co., Dayton, Ohio, $187,884 for assemblies.

Leece-Neville Co., Cleveland, Ohio, $240,625 for assemblies.

Continental Motors Corp., Muskegon, Mich., $277,120 for parts for engines.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., $372,614 for gauge units.

Charles E. Smith & Sons Co., Cincinnati, Ohio, $328,080 for assemblies.

Spriesch Tool & Mfg. Co., Inc., Buffalo, N. Y., $367,400 for assemblies.

Iron Fireman Mfg. Co., Portland, Oregon, $553,796 for mount assemblies.

Bendix Aviation Corp., Bendix, N. J., $1,210,320 for airspeed indicators.

The Yale & Towne Mfg. Co., Stamford, Conn., $505,000 for pump assemblies.

Republic Aviation Corp., Farmingdale, L. I., $3,130,349 for maintenance parts.

Sparks-Withington Co., Jackson, Mich., $633,148 for bomb hoist assemblies.

Rheem Mfg. Co., Chicago, Ill., $112,500 for fin assemblies.

Bendix Aviation Corp., Bendix, N. J. $327,600 for generator assemblies.

P. R. Mallory & Co., Inc., Indianapolis Ind, $468,000 for release assemblies.

Holtzer-Cabot Electric Co., Boston, Mass., $142,560 for inverters.

Holtzer-Cabot Electric Co., Boston, Mass., $444,830 for inverters.

Harrisburg Steel Corp., Harrisburg, Penna., $2,951,980 for gas cylinders.

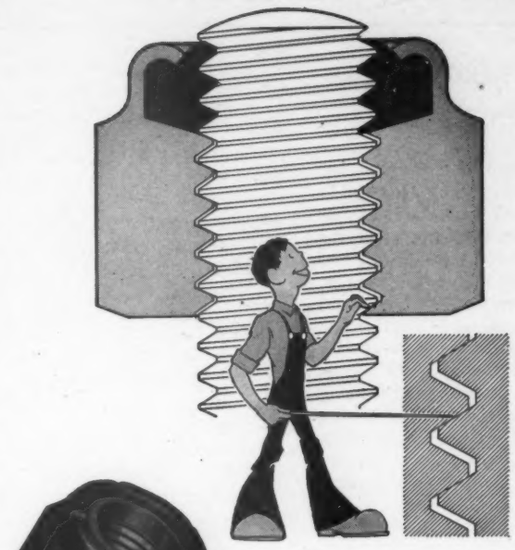
Taylor-Wharton Iron & Steel Co., Easton, Penna., $1,493,457 for gas cylinders.

Sparks-Withington Co., Jackson, Mich., $503,400 for release assemblies.

General Electric Co., Schenectady, N. Y., $1,486,250 for generator assemblies.

Navy Department

None



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. . . because its thread faces are held in pressure-contact

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Canadian Aviation News

By James Montagnes

Pilots training in Canada under the British Commonwealth Air Training Plan now train for 28 weeks instead of 24 weeks, according to an announcement of the Royal Canadian Air Force headquarters at Ottawa on October 31. The course was extended two weeks early in October from 22 weeks. Now pilots spend 8 weeks in the initial training school, 8 weeks in the elementary flying school, and 12 weeks in the service flying schools. Of most importance in the extended course is the time now given to aircraft recognition and in air navigation, while physical training and organized games have taken on more significance in the training plan. In conjunction with the organized games increase has come an order to commanding officers to keep airmen friends as closely together as possible in schools and on assignment for overseas since "team-work is essential to air-war efficiency . . . and the most effective team is composed of friends who know each other's capabilities and have learned to work, play and fight together."

In initial training schools considerably more study will be possible through an increase in lectures. Additional flying hours will be available in elementary flying schools, and instruction will be more equably spread in the service flying schools. Some increase in flying hours and in night flying will also be possible. Training in spotting types of aircraft is being developed through the use of colored sketches and silhouette lantern slides and the playing of card games such as rummy with playing cards bearing unlabelled aircraft silhouettes instead of the usual suits.

Operational schools are also being organized now in Canada to allow pilots, observers and wireless-air gunners to learn to work together as teams, training which till recently had all been done after the graduates of the Canadian schools had gone overseas. Between 30 and 40 Royal Air Force schools are being established in Canada, to be operated under Canadian government authority in conjunction with the British Commonwealth Training Plan, according to Canadian Air Minister C. G. Power.

Fairchild Aircraft, Ltd., Montreal, reports for its fiscal year ending June 30, 1941, net profits of $39,429, after interest, depreciation, provision for loss on inventory of Sekani type aircraft, provision for income and excess profits taxes and all other charges. This compares with a net profit in the previous year of $11,444. Provision for income and excess profits taxes amounted to $27,096 compared with $13,018 in the previous year. Operating profit for the year was $208,943 against $167,522 last year. The report shows uncompleted contracts at June 30 of over $6,500,000, nearly three times the amount of the previous fiscal year.

Figures released by the Royal Canadian Air Force during October show strength of the force at that time at 83,000 compared with pre-war strength of 4,500. Canadian ground crews are now operating in Britain and soon most Canadian squadrons will be serviced by Canadian mechanics.

ONE OF THE ENCLOSED FAIRCHILD TRAINERS of the type delivered to Norwegian flyers training in Canada. M62 Ranger equipped.

On Schedule

By "Vista"

The main line of Japanese penetration into the Southern Pacific, perhaps patterned after German practices during this war, has been the expansion of routes by the Japanese airline, which during the past year and a half have moved down to within easy striking distance of English and American military and commercial airbases in the Pacific ocean. Quite a while ago this column mentioned the new route to the Palau Islands, which at the time very obviously was only started by Japan for military reasons, even though the Japanese claimed it had great commercial value. It crossed Pan American's Pacific services, and since it was officially opened, little more of news value was heard about it, except perhaps the fact that Japanese travelers would have to do without hostesses or "geishas with wings".

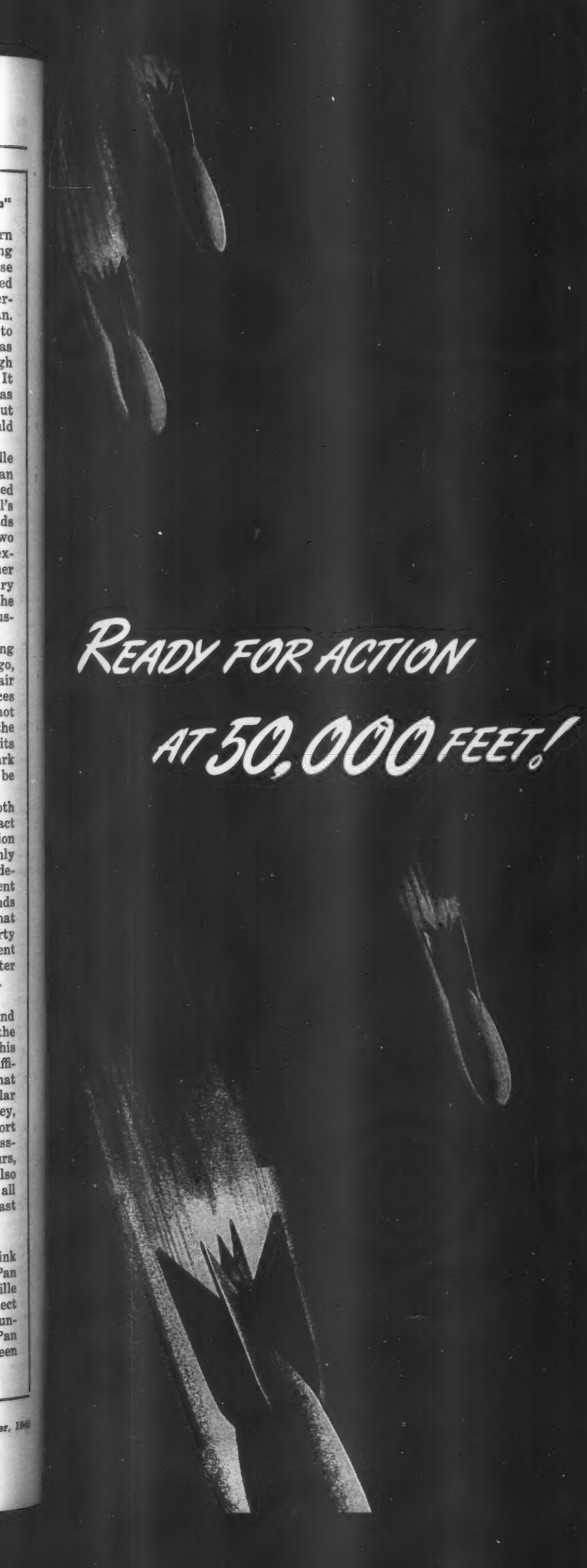
Suddenly, like a bombshell, news came during the middle of October that Portugal, obviously under severe German pressure for concessions to the Axis partners, had granted the Japanese landing rights at Dilli, capital of Portugal's half of the island of Timor, one of a large group of islands very near to the coast of Northern Australia, and about two hours' flying from Port Darwin. The issue was made explosive due to the fact that the Netherlands owned the other half of this island, and that it contained important military and commercial airplane bases, besides constituting the jumping off point of several commercial airlines to Australia, 400 miles distant.

The flight from Palau to Dilli would involve the crossing of a major part of the Netherlands East Indies archipelago, many islands of which are being fortified as naval and air bases for the protection of one of Democracy's main sources of many vital raw materials. Though negotiations have not yet started at this writing, Japan will have to obtain the necessary permits from the Netherlands to fly across its territory, and unless the whole matter is used as the spark in the powder barrel of the Pacific, the route may well be talked to death.

Immediate action appears to have been taken by both the Australian and Netherlands governments to counter-act this latest move of Japan's "commercial" airline; action which was speeded up when the Nippon press openly crowed about this route's military value. Interesting sidelight to the whole matter is the fact that this government has for many years refused permission to the Netherlands to let its commercial airliners fly into Manila, claiming that such a franchise would force them to give similar liberty to Japan, thereby aiding her southward expansion; present developments perhaps will speed the completion of a faster connection between Indies and equally vital Philippines.

Pan American Airways' Clipper passengers to New Zealand have, since the start of this service, been flying to the Australian continent with Tasman Empire Airways. This airline, flying over what is admittedly one of the most difficult airline routes in the world, has accomplished what seemed practically impossible a few years ago, a regular three times fortnightly service from Auckland to Sydney, with a load factor averaging 85 percent per flight. Short flying boats with a 16 passenger capacity are used; grossing 48,000 pounds, the flights take an average of 9¼ hours, though the shortest flight record is 6½ hours and there also have been flights that have taken 12 hours and over; all flights have to be made against or with the constant east headwind, which accounts for the large time variances.

Slowly but surely the American commercial airline link around the world is being completed—on November 29 Pan American will inaugurate the new service to Leopoldville in the Belgian Congo, where the new service will connect with B.O.A.C. airliners which will, for the time being undoubtedly, fill in the gap from the Congo to Singapore. Pan American's air ferry service across Africa has already been in operation for some time, 'way ahead of schedule.



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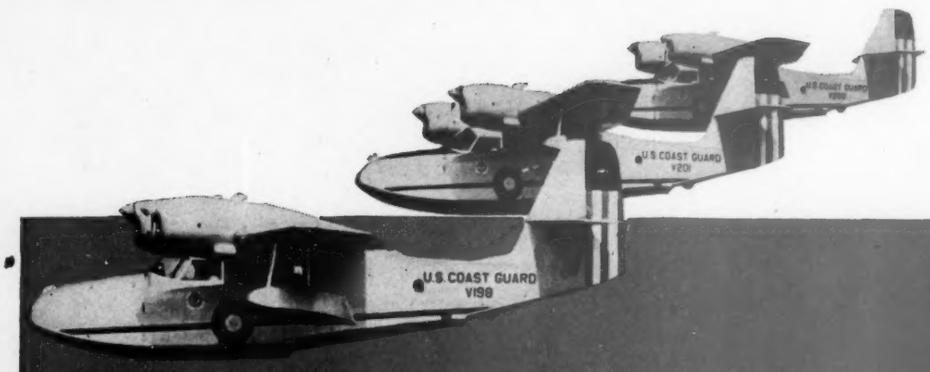

GRUMMAN J4F-1's JOIN THE COAST GUARD

☆ Grumman versatile pocket amphibians, "the airplanes of a hundred uses," are now performing inshore and coastal patrol duties for the U. S. Coast Guard at their bases on the Atlantic, Pacific, Gulf Coast, and the Great Lakes.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

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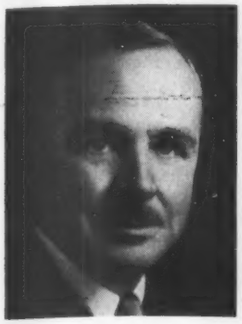


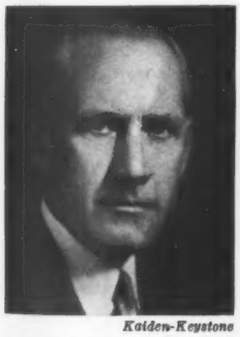
Sperry Gyroscope Co. has separated the administrative and executive functions of its engineering and sales departments. P. R. Bassett, v.p.-engineering, retains executive direction of engineering and E. C. SPARLING (l.), new chief engineer, assumes administrative duties. R. B. Lea, v.p.-sales, retains executive direction of sales, and M. L. PATTERSON (r.), new general sales manager, takes on administrative duties.

New Chief of the Public Relations Branch, Headquarters, Army Air Forces, at Washington, is LT. COL. ARTHUR I. ENNIS. He had previously been Chief of the Still Picture Section, Pictorial Bureau.

Gladsen-Mitchell

A. P. FONTAINE (above) succeeds E. G. Bruce as chief engineer of the Engineering & Development Dept. of Vultee Aircraft, Inc. Bruce is made the company's chief research engineer.

Aircraft Tools, Inc. has appointed GLEN PERIMAN factory manager. Formerly chief tool designer at North American Aviation, he was with Douglas for nine years previously, in charge of small tools.



Kaiden-Keystone

HARRY L. BILL, new vice pres. and gen. manager of Greenfield Tap & Die Corp., was from 1939 president of United Aircraft Products, and in 1935 vice pres. of Pioneer Instrument Co.

International

Parachutist ARTHUR H. STARNES landed safely from a 30,000 ft. jump, opening his chutes at about 1500 ft., thereby establishing a record for the longest free fall made in the United States.

In his new post of Oklahoma City district traffic manager, ROBERT T. PHINNEY, JR. takes charge of Braniff Airways' sales and traffic throughout the state. He joined the line in April, 1939.

Appointment of P. M. DOLLARD as secretary-treasurer of Adel Precision Products Corp. is announced by H. R. Ellinwood, pres. Dollard severs a 17-year connection with Sanderson & Porter.

LAWRENCE D. BELL accepted for the Bell Aircraft Corp., the award of achievement presented by George Washington University for the development and production of the Airacobra.

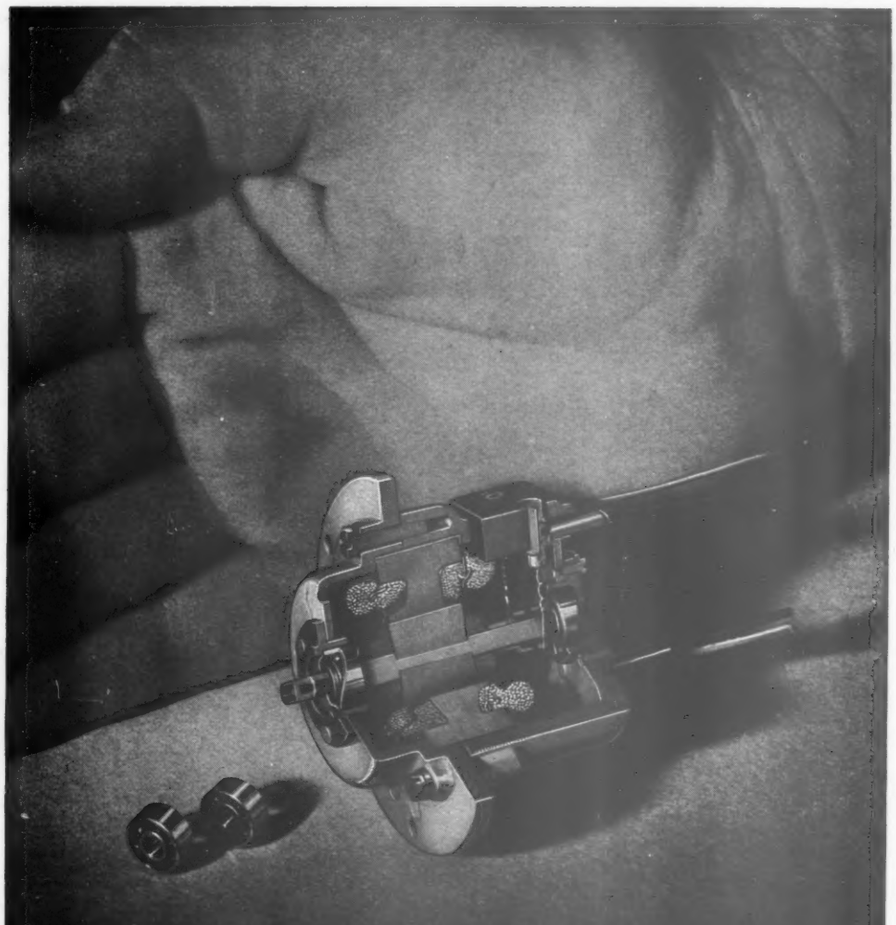
K. R. JAMESON, formerly with Pacific Airmotive Corp., has been elected vice president in charge of sales of Airplane Manufacturing & Supply Corp., according to Earl Herring, president.

Wide World

Navy's newest aircraft carrier Hornet is commanded by CAPT. M. A. MISCHER. Commissioned at the Naval Operating Base at Norfolk in Oct., the Hornet displaces approximately 20,000 tons.

The American Society of Tool Engineers has suffered the loss of FORD R. LAMB, on Oct. 26th. A charter member, past president, and executive secretary, he had made the ASTE his lifework.

New appointments at Chandler-Evans Corporation are HOWARD L. HARTMAN (l.) as assistant general manager, and THOMAS D. HOGG (r.) as factory manager. For seven of his eleven years with Pratt & Whitney Aircraft Division, Mr. Hartman had been assistant secretary. Mr. Hogg is promoted from shop superintendent, having joined Chandler-Evans in 1939 as superintendent. He was with the RAF during the World War.



Nerves for BOMBERS

● Working in pairs, as transmitter and receiver, literally hundreds of these tiny Pioneer* Autosyn Motors in a large bomber tell the pilot the exact functioning of remote, vital parts of the ship.

Like the human nervous system, these motors must be quick-acting, sensitive. Hence, the use of two precise, ultra-sensitive New Departure ball bearings on each rotor shaft. These bearings are delivered to assemblers in oil-filled glass vials, untouched and uncontaminated by human hands.

This is only one phase of the defense effort for which New Departure is working night and day.

New Departure, Division of General Motors, Bristol, Connecticut.

* *Pioneer Instrument, Division Bendix Aviation Corporation.*

New Departure

BALL BEARINGS FOR DEFENSE

3051

Douglas "Cold Room"

At altitudes above 30,000 ft. where bombers and fighting planes are now operating in the present air war, where temperatures range from —48 to —67 deg. F., the intense cold has a deadly effect not only on men, but on their machines as well. For instance, many hose connections get brittle, crack wide open longitudinally, or snap in two. Lubricating oil hardens to the consistency of thick tar. Consider, too, the problems met with by General Electric in developing its turbosupercharger, part of which is in the engine's exhaust stream at 1600 deg. F.; and the other end touching, at 40,000 ft., the outside air at 67 below.

To simulate conditions and effects of extreme low temperatures on the various components of high-flying aircraft, Douglas Aircraft Co. has built a scientific ice box where men and materials may be thoroughly pre-tested and proven. Experiments have been under way since July 20, 1941, the test program including a study, under polar conditions, of fuel, oil and hydraulic systems, controls, structural parts, insulation, heating, windshield deicing devices, bearings, tolerances, metal fatigue, etc.

One great advantage of the Douglas cold room is that its size, about 14x16x8 ft., permits workmen to conduct experiments on the spot, rather than through glass windows and remotely actuated dial readings outside.

Despite extremely low temperatures, from —40 to —104 deg. F., men are able to work in the room without too much discomfort. Wearing sheepskins and air-tight suits made of horsehide thickly quilted with the finest merino wool, the clothes are laced together with zippers from tip to toe and supported from the shoulders by an ingenious suspender system.

A helmet, resembling a diving bell and equipped with earphones and telephone mouthpiece, is made of spun aluminum—not dural—and welded to padded shoulder pieces of the same metal. A fixed visor of laminated Plexiglas separated by air chambers, and hermetically sealed after all moisture has been removed, effectively prevents fogging. Inside, the helmet is lined with felt and chamois skin. Neither suit nor helmet is electrically heated.

Since a principal danger to workmen in the cold room is the possibility of pneumonia, the suit is valved so its wearer breathes air warmed by his own body. The intake is at the waist, the exhaust in the helmet dome.

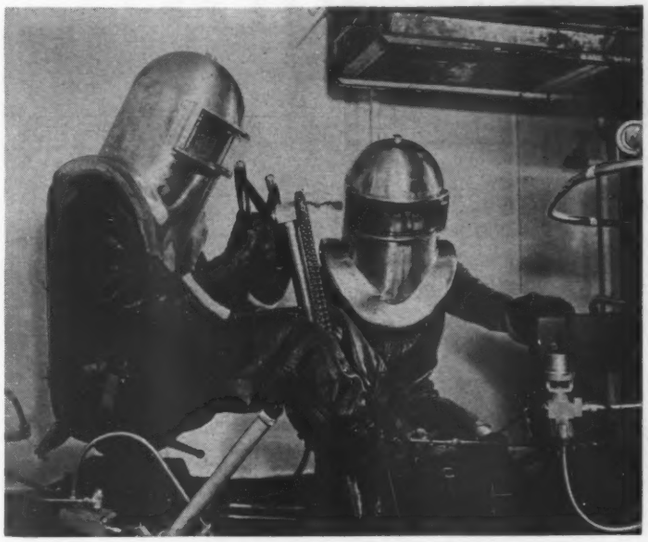
Temperatures in the "frigidaero" are lowered by means of a combination of dry ice (CO_2) and methyl alcohol. Agitated together and pump-circulated through a so-called heat-exchange unit, this apparatus will cause the temperature to fall from plus 80 deg. to minus 104 within 2 hrs.

The room is insulated with 12 in. thick fire and corrosion proof spun glass. Windows consisting of four panes of hermetically sealed glass are installed to permit outside observers to watch the workmen —or victims, according to the way one feels about 104 below.

One man never goes into the frigidaero alone. Additional safety precautions include instant communication outside, by means of the telephonic equipment fitted in the helmets, and by outside observation.

The Douglas cold room tests are conducted by engineering development in charge of J. R. Goldstein. Associated with him in this work are E. P. Wheaton, Dr. W. B. Klemperer and T. N. Floyd. Mr. Floyd designed the cold room and coordinates its experiments.

Of further interest is the report that one of the compression chambers in the Douglas altitude laboratory will soon be hooked up to the cold room so that aircraft parts and equipment may be subjected to the effects of high altitudes as well as firmamental cold.



CLOSEUP OF RESEARCHERS in coldroom at work on high altitude tests. Note man at plane control wheel, and air intake hose for breathing near waist. Outlet in dome of helmet.

New Drafting Board

Taking a load off the feet and stomachs of the men who have spent most of their lives standing or leaning over drafting tables, a new type of engineering drafting board which cranks up and down like the window of an automobile has been developed by the engineering department of The Glenn L. Martin Co. in Baltimore.

When not being used, the board lies flat on its desk top. The draftsman, seated in his chair, twirls a small window-type crank which raises the board to the desired level. Then, by means of a horizontal bar beneath the edge of the board, he adjusts it to the proper angle. The board is kept in firm position by a "dog" controlled by the bar, which drops into a notched locking sector.

The Transmissometer

National Bureau of Standards is developing an instrument to determine automatically the extent to which light is transmitted through the atmosphere under varying conditions as an aid in improving lighting systems of airports and airways.

The transmissometer, as it is called, will measure the transmission of light between two points and relay a code signal to some remote point, by wire or radio, there to be recorded.

Instrument is said to have worked satisfactorily both in the laboratory and in field tests. Last summer at Nantucket Island, one of the foggiest locations in the U.S., considerable data were obtained to correlate readings of the instrument with the visual range under different atmospheric conditions.

When its development has reached a wholly satisfactory stage, the transmissometer will be installed at representative localities and the readings correlated with estimates made by trained observers. Such an instrument would make it possible for aviation weather observers to give measured values of visibility instead of depending on estimates of visual range.

IN ACHIEVING MASS PRODUCTION of hydraulic valves, Adel Precision Products Corp. has developed such complete test panels as these, each fully equipped for test pressures of 200 to 10,000 lb. per sq. in.

Seaboard Plans Line Boston-Miami-Orleans

Washington (AVIATION Bureau)—Seaboard Airways' application for a certificate to operate a route from Boston via Washington to Charlotte, and splitting there to Miami and New Orleans, is the subject of hearings by the Civil Aeronautics Board as this is written.

A number of other airlines, including Eastern, American, Penn Central, Pan American, some railroads and some cities have intervened against Seaboard. In addition to Seaboard, other airlines, including Canadian Colonial, National, State, Penn Central have made applications for establishment of another East Coast line.

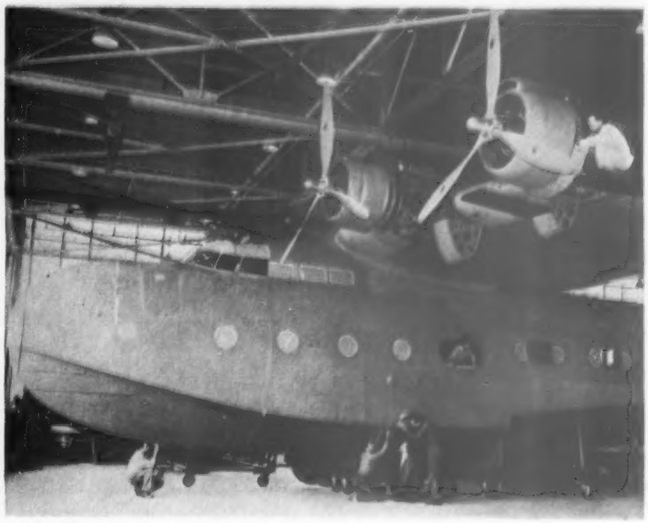
The present application is made by a Seaboard concern which no longer has any connection with the railroad of that name. Alvin P. Adams, formerly head of Western Air Express, is president of Seaboard, and the other officers are members of Ladenburg Thalmann, a New York financial house. They have formed a syndicate to finance the project.

If the certificate is granted, the company expects to start operations July 1, 1943. Its officials are aware that even though a certificate is granted, permission of the Army is still necessary before planes can be allocated for additional civil routes. This restriction is made under joint agreement between the Army and the Civil Aeronautics Authority.

Company expects to use 11 planes at the start—either Lockheed "Excalibur" 44s, or Curtis CW 20s, or Douglas DC-6. The Lockheed 44 is a four-engined plane, smaller than the Constellation, three of which are under construction for another airline. None of the 44s has yet been built. The CW 20 is being built, in small numbers up to now, for the Army Air Force for use as transports. The DC-6, not under construction as yet, will be an enlarged and modernized version of the DC-3, for the past several years used on most domestic airlines and throughout the world.

Seaboard's proposed schedule calls for a local trip each way each day during the first month, using day planes. During the second month, a night local trip each way will be added. In the sixth month an express trip will be added each way daily, and in the seventh month an extra express to Miami is called for. Later on, it is expected, a high speed cargo trip would be put on the Boston-Washington section, possibly to be extended later to Charlotte, where the load would be split between the regular planes.

Representatives of the company said that these schedules will be much faster than would be possible with present-day equipment. They said that both Miami and New Orleans seemed well pleased with the prospect of the service. They stated that another line on the East Coast, to compete with the one existing line, is desirable under the law. American Airlines follows the coast only as far South as Washington, where it turns inland on its route to California.



GIANT HULL and port engines of one of three Vought-Sikorsky flying boats rapidly nearing completion for American Export Airlines at Stratford, Conn. They are designed for non-stop crossing of the Atlantic with full passenger, mail and express loads, at a cruising speed of 175 m.p.h. Sleeping accommodations for 16 passengers are provided, but they can be equipped to carry 40 on daytime flights.

PAA Calls On Fijis Starts African Service Doubles Far East Runs

The Fiji Islands, with $20,000,000 annual business in cane and copra, a strategic position in the South Pacific amid the Far East rumpus, and just 1500 miles from the Japanese Caroline Islands, got their first service Oct. 30 with a new Pan American Airway stop on the route to New Zealand.

The Fiji Islands recently lost all contact with the outside world because shipping companies had removed boats for war business; only the Matson Line stop, once a month, remains. So the clippers come in handy. For Pan American, the new service sets up two additional fuel stops; one alternate at Palmyra Island, and one at Suva, capital of Fiji, which add more than 30 percent payload. This is important, with the Mediterranean - Suez route closed; more Europe-bound goods, mail, passengers will be flown to the U. S. and across the Atlantic.

To strengthen its links to the far East, PAA has moved the S-42B, 4-engined Sikorsky Bermuda Clipper to Manila, whence it will run twice a week to Hong Kong. The regular Pacific Clippers thus can go on through to Singapore each week instead of every other week as before.

PAA started, after vast preparations, its 11,898-mile service from Miami to Leopoldville, Belgian Congo, to Khartoum, Egyptian Sudan. (See AVIATION, Nov. 41, page 126). Company says this is its biggest job to date. The development is in three phases: Clipper transport service to Leopoldville; overland transport route from Leopoldville to Khartoum; ferry service for U. S.-built military planes to Britain, China, Russia. (Some ferried planes go also by way of Guam, Midway, Wake Islands; some by way of Alaska to Siberia; and most over the North Atlantic from New Foundland)

Postmaster General Frank C. Walker started mail service on the new PAA African route November 29. Not least pleased were the stamp and cover collectors.

Two Airline Accidents End 6-mo. Safety Run

Washington (AVIATION Bureau)—Two airline accidents on October 30, killing a total of 34 persons, ended the new no-fatality record of exactly six months and three days, following the Jonesboro, Georgia, accident, in which eight persons were killed, and Capt. Eddie Rickenbacker was injured.

One of the October 30 accidents was a Northwest Airlines DC-3, at Fargo, N. D. The ship apparently was making an instrument approach to a landing when it contacted the ground about three miles from the field, bounded across a ravine, and burned, killing 14 persons.

The other was American Airlines, DC-3, which struck an open field 14 miles west of St. Thomas, Ontario, on the Buffalo-Detroit Route, and burned, killing 20 persons.

There will be no official information on the cause of the accidents until the Civil Aeronautics Board, which started investigations immediately, issues its reports some weeks hence. Pilot Clarence Bates, only survivor of the Northwest accident, is reported saying that the plane vibrated and the controls stiffened as he made his landing approach. He had picked up what he said seemed a small amount of ice.

Survival of the pilot in a major accident is an important stroke of good fortune, on other than his own account. Investigations of major accidents do not often have the advantage of an expert eye witness report.

There were 10 fatal airline accidents in 1936; six in 1937; eight in 1938; three in 1939; three in 1940; and thus far five in 1941—St. Louis-TWA, Jonesboro-EAL, Vero Beach-EAL, and the two under discussion.

The longest no-fatality period was March 26, 1939 (Braniff at Oklahoma City) to November 4, 1940 (Penn-Central at Lovettsville) — just over 19 months. This was a domestic record, however, as Pan American Airways had a fatal accident in Brazil on August 31, 1940, killing 25 persons, including the crew of four.

The October 30, 1941 accidents of Northwestern and American did not seem to stir up any moves to re-organize the Civil Aeronautics Authority, as other accidents did.

Studies Mail Pay

Washington (AVIATION Bureau)—The Brookings Institution, endowed research group which often publishes analyses on public problems, has upset the Civil Aeronautics Board mildly with a statement, in a comprehensive report on "Air Mail Payment and the Government," that profits on some airlines have increased so much that the Board must now consider whether to take its first step toward regulation of passenger and cargo fares. This it is empowered by law to do when it sees fit.

The Board itself appears to be making no separate study of this matter, except as broad questions of policy develop in individual rate cases.

TRANSPORT DOINGS

Pan American makes a gross profit of $806,200 in the sale of three Boeing clipper ships to the British, for $1,035,400 each, according to a CAA examiner's report.

Transcontinental's new salary scale gives hostesses $115 per month to start, increasing to $135 at the end of the first year of service. Periodical increases are granted with increased seniority. The new scale is in line with recent increases granted other TWA personnel.

Eastern adds Atlantic City as a passenger and mail stop on its route between Philadelphia and Baltimore. Company is hiring pilots at the rate of 10 per month and in the event that Douglas DC-3 Silverliners now on order are delivered in 1942, one hundred more pilots will have been added. Service between New York and Brownsville, and between New York and San Antonio, will be one continuous route, consolidating routes Nos. 5, 20, and 42.

Chicago and Southern's stewardesses give matrimony as the reason for leaving their jobs in 99 percent of the cases. Each of nine flight captains will be given a Gruen watch by R. L. Simpson, Pres., of the New Orleans Association. The pilots to receive watches have flown more than a million airline miles.

Penn-Central recently carried its 900,000th passenger. O. C. Durham, noted botanist, completes a 3,000 mile aerial study of the distribution of hay fever pollen for the company.

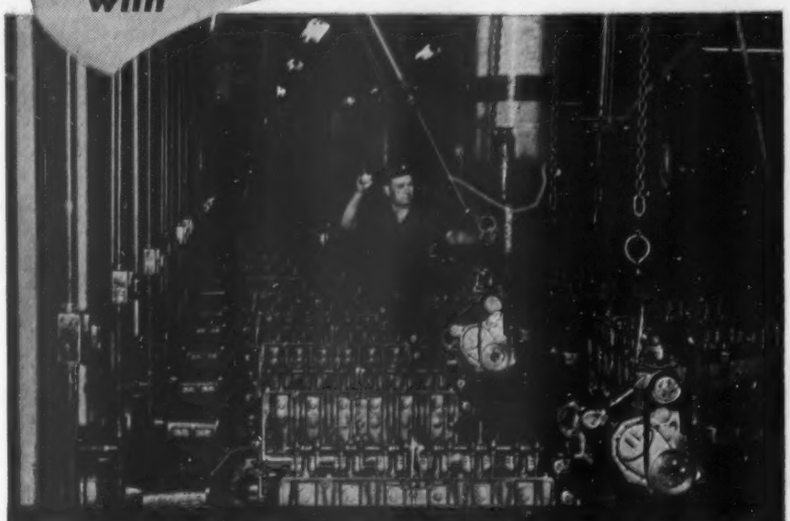
Transcontinental, Mid-Continent, Braniff and Chicago & Southern will serve as guest lecturers at Stevens College course designed to familiarize young women with commercial airline operations and to point the way to the careers in the industry.

Air Express reached an all-time peak in August with 1,842,858 pounds carried. The average haul of air express has decreased in the past two years from a high of 695 miles in 1937 to 554 miles in 1940 and the downward trend continues.

FASTER *More Efficient* LIFTING

- Release Men for Other Work
- Increase Plant Capacity

with



CURTIS AIR HOISTS

A tough problem — Insistent pressure for increased output in the face of a shortage of skilled labor. The solution — Install a CURTIS One-man Air-Power Hoist and release some men for other jobs and at the same time make the lifting job faster and easier; also more efficient by reducing man fatigue.

Illustrated above is a large automobile manufacturing plant that uses CURTIS Air Hoists to lift and place motors on testing blocks. This continuous heavy duty job is now a fast, easy, one-man operation.

CURTIS All Steel Air Hoists are smooth in action, speedy, and efficient. They provide extreme accuracy of control and will handle the most delicate hoisting operations. Any workman can operate them—the hoist does all the work by air power. Dead weight is extremely low, allowing light supports as well as easier moving of trolley mounted loaded hoists. Available in pendant, bracketed and rope compounded types. Cannot be damaged by overloading and are unharmed by steam, fume or dust-laden atmospheres.

For complete information as to how you can step up production and lower costs in your plant, send for free booklet "How Air is Being Used in Your Industry"—mail coupon today.

CURTIS

St. Louis New York
Chicago San Francisco
Portland

CURTIS MANUFACTURING COMPANY
1957 Kienlen Avenue, St. Louis, Missouri

Please send me your free booklet "How Air is Being Used in Your Industry" and further details concerning Curtis Air Hoists.

Name.....

Firm.....

Address.....

City..... State.....

CONSOLIDATED B-24'S FABRICATED WITH BOOTS SELF-LOCKING NUTS

80,000 POUNDS LIGHTER— THANKS TO A "MAGIC" NUT

A single fleet of planes, being built for the United States Government by Consolidated, will carry 80,000 pounds★ less dead weight, solely through the use of Boots Self-Locking Aircraft Nuts. As one result, they can lift that much more fire-power, armament or fuel.

Boots Nuts are of sheet metal construction—have all the required tensile strength of old-fashioned nuts. They "outlast the plane," and can be reused as often as required in the airplane's maintenance.

The only one-piece, all-metal, self-locking nut to pass the rigid tests of the Army, Navy and Civil Aeronautics Authority.

★Consolidated's chief engineer figures a weight saving of 40 to 80 lbs. per B-24 due to use of Boots vs. nuts used in the past.

BOOTS

AIRCRAFT NUT CORPORATION

NEW CANAAN, CONNECTICUT

Control of Culver Aircraft Corp. has been acquired by Walter H. Beech and Charles G. Yankey, president and vice president, respectively, of Beech Aircraft Corp. The new controlling interests have taken over management of the Culver plant which is working on approximately $1,000,000 in government orders and several hundred thousand dollars of commercial orders.

Aviation financing: New York and Philadelphia bankers plan to offer to the public 20,000 shares of Class A stock of **All American Aviation, Inc.** at $4 a share. The offering does not constitute new financing on the part of All American Aviation. Riter & Co. of New York recently sold 140,000 shares of **Jacobs Aircraft Engine Co.** at $5.25 a share. This stock was sold for the accounts of certain stockholders. Other financing included an offering of 150,000 shares of capital stock of **Adel Precision Products Corp.** by Detroit and Los Angeles bankers. The stock was priced at $3 a share.

Seaboard Airways, Inc., formerly owned by the receivers of Seaboard Airline Railway, will be financed by the banking firm of Ladenburg Thalmann & Co. according to a recent court authorization. Under the agreement, the bankers will finance the airways' application before the CAB for permission to start operations.

Kellett Autogiro Corp. has repaid a $175,000 loan obtained from the Reconstruction Finance Corporation in October, 1940. Kellett has a backlog of unfilled orders in excess of $4,000,000 in subcontracting work for prime airplane manufacturers.

Northrop Aircraft has negotiated a credit in the amount of $3,500,000 with the Chase bank and Manufacturers Trust Co. of New York. This credit is to provide any needed financing of inventory that may be necessary.

T.W.A. and the New Haven railroad have established a new airline corporation in which T.W.A. will have 55 percent control. The new company is expected to apply to the CAB for permission to operate a comprehensive network covering many New England cities.

Curtiss-Wright Corp. leads the aircraft concerns with defense orders outside the aviation field. One of the Wright engines is standard equipment on armored tanks and with the Administration planning to nearly triple the present tank program Curtiss-Wright will be called upon to power a large number of these juggernauts. **Continental Motors** also is a big supplier of tank engines under license from Curtiss-Wright.

United Aircraft Corp. has set up a special reserve account of $4,000,000 out of its nine months' operations to provide for the transformation from defense production to a peace-time economy. The company also has charged off around $11,000,000 for three buildings which were erected in 1939 to handle British and French contracts. The cost of these buildings is amortized as deliveries on these foreign orders are made and the company has another $5,000,000 for completely charging off these buildings during the life of the foreign contracts.

American Airlines took ten years to carry its first million passengers but in this year alone the company will haul its fourth million. This big traffic gain is being absorbed with less airplanes than the airline had in operation a year ago.

Republic Aviation shipped more combat planes in October than it did in the first six months of 1941, when deliveries totaled $2,892,000. The company's new $6,000,000 Long Island factory is now in operation.

Douglas Aircraft has just paid a $5 per share dividend to its stockholders, the same amount the company declared a year ago. Although earnings this year are running well ahead of the previous year, the unchanged dividend rate reflects the management's decision to follow a conservative dividend policy in view of the heavy working cash requirements of a rapidly expanding production program.

Consolidated Aircraft is delivering each month approximately the same dollar value of airplanes as it did in the first ten years of the company's existence. Major R. H. Fleet, president, believes that output will be expanded to the point where by next summer Consolidated will have as large a volume in a ten-day period as it had in its first decade.

Vultee Aircraft is not expected to declare dividends this year due to the management's desire to conserve cash resources at this time. For the nine months ended with August, deliveries amounted to about $18,000,000, as against $5,600,000 in all of last year. Another $18,000,000 in deliveries were expected to be made in the three months ended with November of this year.

Cessna Aircraft will report record earnings for the year ended September 30, 1941, according to well informed Wall Street quarters. Shipments in the final quarter are said to have totaled around $8,000,000, compared with only $431,000 in the entire previous fiscal year.

North American Aviation's 1941 purchases of outside labor and materials will amount to around $100,000,000, compared with $45,000,000 in 1940. Some 30 percent of current output is farmed out.

Here and There . . . Beech Aircraft deliveries in the 1941 fiscal year were 430 percent ahead of the previous year . . . Cessna is negotiating for the biggest order the company has ever received . . . Northrop's annual production is between $25,000,000 and $30,000,000 . . . Defense officials are talking of raising the goal of 500 four-engine bombers a month . . . United Air Lines reports its express business 60 percent higher that last year . . . Charles A. Miller, assistant traffic manager of Pan American Airways has been elected president of Airlines Terminal, Inc. . . . Boeing added 10,000 employees in less than ten weeks recently, bringing the total force to more than 21,000 . . . Payrolls in California aircraft and shipyard plants are expected to expand by 65,000 in the next six months.

By Raymond Hoadley

Aircraft companies, it might be noted, have stepped up their dividend payments this fall in a number of cases—usually a trustworthy indication of increased earning power. So far the defense boom has not proved as profitless for aviation as Wall Street has feared it would be and, incidentally, as it has proved to be for a growing number of other industries. As a matter of fact, 1941 earnings of the majority of companies, both large and small, will be at record levels despite higher costs, taxes and declining profit margins in the later months of the year. Big volume, efficient management and mechanization have more than offset the opposing factors. One large company is delivering the same dollar volume in airplanes each month it did in the first ten years of its existence. Six months hence this concern will ship that same volume every ten days! Another, through the use of a powered mechanized assembly line, has passed its employment peak although incoming orders and deliveries continue to rise. The airlines, like the manufacturing companies, have experienced a record breaking business this year but their earnings continue spotty. Some of the larger transport units are reporting larger profits for the fall months than they did last year. Most of the smaller airlines, on the other hand, are running slightly behind and the over-all picture for 1941 is one of higher revenues but lower profits.

Current Earnings Reports

Company	Period	Net Profits 1941	Net Profits 1940	Profits per share 1941	Profits per share 1940	Sales 1941	Sales 1940
Aero Supply	9 mos. Sept. 30	$504,866	$312,468	$1.19	$0.72	$5,442,467	$2,557,212
American Airlines	9 mos. Sept. 30	2,106,234	1,556,849	3.38	4.30	19,393,763	15,152,162
Borg Warner	9 mos. Sept. 30	6,350,930	4,125,231	2.72	1.76	.....	.....
Consolidated Aircraft	8 mos. Aug. 31	3,611,015	.....	5.57	....	52,648,549	.....
Continental Motors	9 mos. July 31	2,236,164	389,138	0.75	0.13	.....	.....
Douglas Aircraft	9 mos. Aug. 31	10,733,046	7,288,335	17.89	12.15	85,093,710	45,430,275
Fairchild Ltd	12 mos. June 30	39,429	11,444	0.31	0.09	.....	.....
Northrop	12 mos. July 31	L 848,778	.....	....	....	3,327,379	.....
Square D. Co	9 mos. Sept. 30	2,255,876	1,263,002	5.17	2.82	.....	.....
United Aircraft	9 mos. Sept. 30	10,771,732	10,461,127	4.05	3.93	203,435,155	79,023,797
Vega	6 mos. June 30	150,925	18,687	0.33	0.04	.....	.....

L — Net Loss.

Material Shortages

The sudden acute shortage in copper has taken the defense metal spotlight away from both aluminum and magnesium, temporarily at least. Fortunately, however, the aircraft industry will not be one of the many industries whose supplies of the red metal will be severely restricted or embargoed entirely after the first of the year. Therefore the main metal worries of the aircraft industry revolves around the amount of aluminum the United States and Great Britain will ship to Stalin, as well as the accelerating demands of the English for our magnesium.

Russia has asked England for a great amount of aluminum (we aren't allowed to give figures here) and Prime Minister Churchill has decided to give them all the metal they requested, according to defense officials. As England's supply of the white metal comes largely from Canada, the latter may have to shut down again on her exports to this country. Our Canadian aluminum imports have risen from zero in August to 4,000,000 pounds per month this past fall. Jesse Jones, Federal Loan Coordinator, had hoped to buy 200,000,000 pounds from our neighbor to the north in the next two years or so.

And in the case of magnesium, the increasing tempo of British air raids over Germany may readily call for larger supplies of American magnesium for bombs. An offset may be the fact that some British magnesium plants, damaged in last winter's blitz over the embattled isles, are understood to be back in production. Meanwhile, there were broad smiles in OPM early in November, when the word came through that Dow Chemical had started production in its latest new magnesium plant down in Texas.

As regards the domestic production picture in aluminum, 58,725,000 pounds were produced in October; 2,500,000 pounds by Reynolds Metals Company and the balance by the Aluminum Company of America. Three months ago total output hovered around the 50,000,000 mark. Ninety-five percent of the aluminum scrap collected in the pots and pans campaign last July was either in the hands of the smelters or in transit to them. The appeal to aluminum manufacturers for scrap also has caused monthly collections of this scrap material to jump from 900,000 pounds to 1,500,000 pounds, according to OPM authorities. Consequently, the scrap aluminum situation has improved materially in the last two months.

Thus it is that the supply of aluminum is adequate currently for all aircraft needs and there is enough magnesium for the most essential aviation needs for that lightest of all metals. But in the field of manufactured parts there are continuing "shortage" difficulties. A year ago there was much talk about the aircraft engine bottleneck. Engine production in November is estimated by military experts to have totaled between 4,500,000 and 5,000,000 horsepower. In fact, their output has outdistanced that of airframes and a new shortage in propellers has developed.

Here again there is every prospect of relief by spring. General Motors Corporation's Dayton propeller plant will be in full output by March and the Williamsport, Pa., plant of Aviation Corporation will come into production about the same time. The latter concern's new Toledo factory will be ready in about six months while Nash-Kelvinator will be turning out propellers in good numbers in the spring. The new Curtiss propeller plant at Beaver, Pa. also will start operation in the near future.

Industry Backlog

Defense orders of the aircraft manufacturers have passed the eight billion mark for the first time and now total approximately $8,343,000,000, up $400,000,000 in the past month despite record high deliveries. They are more than double the unfilled aircraft orders of a year ago and are sixteen times larger than they were three months after war was declared. At the same time the plant expansion program continues apace with the government allocating more than $60,000,000 for additional plant and equipment in the past month.

Military aircraft production has hit the half-way mark towards President Roosevelt's original goal of 50,000 planes a year. Output is now less than 10 percent below the production schedules set up a year ago and defense authorities expect the program will be up to schedule by the year-end.

Aircraft deliveries now amount to better than 2,000 planes a month. By the middle of 1942 they will accelerate to around 3,000 a month. The automobile industry will become an important factor in aircraft production for the first time early next year. The Buick division of General Motors Corp. is already in the initial production stages on its Pratt & Whitney engine order. Ford Motor Co. and Packard Motor Co. are turning out from three to six aircraft engines a month. Ford expects to step this up to forty a month by next summer and plans to have seventy-five big Consolidated bombers rolling off the assembly lines every thirty days by next fall. Studebaker schedules call for more than 500 engines a month by late spring and Nash-Kelvinator Corp. expects to be in mass production at about the same time. Fisher Body Co. is shipping bomber plane sections to North American Aviation. Meanwhile the aircraft industry itself has increased its output at a faster clip than has any other country at any time.

The following table gives the latest approximate backlogs of the defense aircraft producers:

Aviation Corp. ..	$26,000,000
Beech	85,000,000
Bell	140,000,000
Boeing	622,000,000
Brewster	92,000,000
Cessna	27,000,000
Consolidated	725,000,000
Continental Motors	26,000,000
Curtiss-Wright ..	995,000,000
Douglas	670,000,000
Fairchild	26,000,000
Ford	736,000,000
General Motors ..	720,000,000
Grumman	67,000,000
Jacobs	20,000,000
Lockheed	625,000,000
Martin	630,000,000
Nash	45,000,000
North American..	374,000,000
Northrop	75,000,000
Packard	200,000,000
Republic	130,000,000
Ryan	14,000,000
Studebaker	100,000,000
United Aircraft ..	445,000,000
Vultee	178,000,000
all others (vendors)	550,000,000
	$8,343,000,000

Jacobs At Pottstown

Jacobs Aircraft Engine Co. has broken ground for a new plant in Pottstown, Pa., which is estimated to cost $13,000,000. Structure will be new "blackout type", with no windows.

For past decade Jacobs has been a leading engine manufacturer in the 200-400 hp. range, and planes powered by Jacobs motors are in more than 26 countries throughout world.

Company, which was started at beginning of the depression —remember?—rapidly grew to be one of largest of engine producers; is now to go into production on Pratt & Whitney engines. For this the new plant, now building, is necessary. More than 3000 men are to be employed at the Pottstown factory.

Steadily mounting engine production of United Aircraft Corp. in its East Hartford plant was reflected in announcement that contracts have been awarded to Turner Construction Co. for two additional test buildings. Structures will measure 80x95 ft. each, house four 16-ft. production test cells. Work is now under way on two similar buildings, 122x70 ft. and 203.6x41 ft. respectively. Two others were completed last year—all designed by Albert Kahn, Inc.

Conveyor-belt assembly is rapidly invading the aircraft plants. Latest example is at Martin, where a conveyor is credited with halving man-hours on certain small sub-assemblies. The belt is used simultaneously for production of a number of assemblies involving drilling and riveting operations. An assemblyman at the head of the line loads the jigs, puts them on the belt. A drill-pressman picks them up, drills certain holes, and replaces them on the belt.

Substitution of wood for aluminum in both trainer and combat planes is being pushed, Congress was told by Army, Navy, and OPM officials, who urged increased appropriations for Agriculture Department's Forest Products Laboratory. The laboratory is engaged in developing wooden aeronautical materials.

With a backlog of $3,000,000 in trainer plane engine orders, and a net profit for the third quarter of the year of $57,554.35, Earl Herring, vice president and general manager, has announced receipt of a substantial order for Kinner engines from the Dutch East Indies. This is the first order for Kinner engines from this territory. The engines will be mounted in Ryan planes.

A NONSTOP RECORD of 1,700 miles for light planes was established by Mrs. Evelyn Burleson of Albany, Ore., when she flew her Taylorcraft, "Miss Liberty" from British Vancouver to Mexico in 16½ hours. She carried 300 lb. of extra gasoline.

Wright Brothers Lecture

Prof. Richard V. Southwell of Oxford University, England, will deliver the annual Wright Brothers Lecture for 1941 before the Institute of Aeronautical Sciences in New York on December 17. The subject of his lecture will be "New Pathways in Aeronautical Theory", which will be presented at Columbia University, the thirty-eighth anniversary of the first airplane flights made by the Wright Brothers at Kitty Hawk, N. C. The Wright Brothers Lecture has been presented by the Institute of the Aeronautical Sciences on December 17 each year since 1937.

Cessna Will Build "Car of the Air"

Cessna Aircraft Company announces it will produce after the war a "family car of the air," which will not resemble in appearance any airplane ever built; whose safety features will be far in advance of any "fool proof" planes yet produced; and the cost will be in the same price range as present day automobiles.

Operating cost of the plane, according to the announcement by Dwane Wallace, president of the Company, will be much less than that of cars in today's "low-price class."

Biggest Show On Earth

Plans for the annual Miami All-American Air Maneuvers got off to the earliest start in 14 years, with indications pointing to a bang-up 1942. Directors of the annual Miami "Aerolympics" forecast not only the biggest aerial show of all time but anticipate a large gathering of America's aviation fraternity in Miami during the three days of the meet scheduled for January 9, 10, and 11.

As the world's oldest annual air show, it offers a program including stunt aerialists, precision flying teams, air comedy acts, parachutists and a racing program that gives stock owners a chance to participate in America's No. 1 air show.

Mjr. Philip J. Roosevelt

Major Philip J. Roosevelt, who was Military Editor of AVIATION in 1916 and 1917, was drowned on November 8th near his home at Oyster Bay, Long Island. He left AVIATION to enter the Army Air Service in 1917 and was attached to the pursuit wing of the First Aviation Group in France. He served a year and a half overseas and won the French Croix de Guerre. When he died he was a member of the firm Roosevelt & Son, investment bankers, and a director of many corporations. He was an owner of several yachts, Commodore of the Seawanhaka - Corinthian Yacht Club, and President of the North American Yacht Racing Union.

CALLING NAMES

William A. Bohannon, tow-sign advertising service, has bought the wingless autogiro that first flew air mail on schedule between a Camden Airport (later, Philadelphia Municipal Airport) and the rooftop of Philadelphia Post Office for Eastern Air Lines.

Capt. H. H. Holloway, TWA Stratoliner pilot on the Los Angeles-Albuquerque Div., recently sighted 30 craters between Chevalon and Wild Cat Canyons. Edsel Ford and TWA are investigating to see if caverns underlie the area.

Wally Smith is made district manager at Honolulu for TWA.

E. G. Lochiel, treasurer and comptroller of Penn-Central, is elected first v.p. of the National Association of Cost Accountants.

James H. Baldridge of Pittsburgh is named personnel director of Penn-Central.

Orville Wright, now 70, who, at 10:35 am December 17, 1903, made the first power flight, walks about Washington unrecognized even by the big men in aviation.

Lt. Bob Kinhead, who about a year ago left United Air Lines to join the information staff of the Air Force, Washington, is now on leave as assistant to James Murray, Boeing representative in the Capital these many years.

Capt. Frank Miller, formerly of the public relations section of the Air Force, has been transferred to Wright Field.

Reynolds Metals Co. is donating a training plane to Richmond-Hopewell-Petersburg regional flying corps unit, approved as part of the Virginia Protective Force.

O. W. Tupper is appointed administrative assistant on the staff of **P. G. Johnson,** president of Boeing, rejoining the company after an absence of 12 years.

Charles A. Miller, asst. gen. traffic mgr. of Pan American, is elected president of Airlines Terminal, New York.

Maurice Roddy, aviation editor of the Chicago Times Syndicate, and v.p. of AWA, is named chairman of the National Committee on Aviation of the National Exchange Club.

Col. David N. W. Grant, Chief, Medical Division, Air Corps, is the first officer to be named to the newly created post of Air Surgeon. He will be a member of the staff of **Maj. Gen. H. H. Arnold** and will head a medical service to coordinate the medical activities of the Army Air Forces. He retains his post as Chief of the Medical Division, Air Corps.

Lt. Col. James B. Newman, Jr. is assigned to the Army Air Forces for service on the Air Staff in Washington. He has been district engineer at Wright Field and will act in an advisory capacity on engineering matters on the staff of **Maj. Gen. H. H. Arnold.**

Madam Frances Perkins visited the Boeing plant,—got first-hand information by crawling into jigs.

Asst. Secretary of Navy for Air Artemus L. Gates and **Rear Admiral A. L. Lyster** of British Royal Navy toured North American Aviation plant. **Col. Oscar Moscoco** of Bolivian Air Force also toured the plant.

Granville M. Greene is appointed asst. supervisor of fleet service for American Airlines. **Redmond J. Lyons** is made assistant to the supervisor of fleet service.

Lyman G. Hill becomes western manager of Technical Ply-Woods and **Allan P. Crawfurd** advertising manager.

H. F. Robertson takes over Hartford office of Jessop Steel Co. as district manager.

Frank A. Burnett is promoted to Indianapolis office of Ampco Metal, and **E. A. Svoboda,** formerly at Indianapolis, replaces **J. A. Morrison** at Cleveland.

Gregory Daymond and **Chesley Peterson** are first members of American Eagle Squadron to receive Distinguished Flying Cross.

E. N. Whitney, former chief dispatcher of Western Air Lines is made assistant to v.p. of operations, **C. N. James. Richard A. Dick,** asst. gen. traffic mgr., is named gen. traffic manager under **Thomas Wolfe,** v.p.-traffic.

John R. West, president of West-Marquis, is elected president of Southern California Chapter of N.A.A.

E. D. Starkweather becomes personnel director of Inglewood plant of North American Aviation, with **A. W. Hale** as his assistant.

L. T. Cohu, J. K. Northrop, G. H. Irving, M. W. Stephens, B. F. Lester, H. W. Cohu and **R. L. O'Brian** are reelected directors of Northrop Aircraft. **T. C. Coleman** and **G. L. Sterling, Jr.** are newly elected to the directorate.

O. B. Whitaker is promoted to marine sales manager of Sperry Gyroscope Co.; **Stanley Bedell** to export sales manager; **F. B. Voss** to aeronautical sales manager; **E. F. Lazar** to manager of Federal department; **Paul Fitzgerald** to asst. manager of Federal department.

R. W. Boise, Jr. heads new Boeing industrial engineering department.

Cecil Register, Eastern Air Lines assistant chief flight-steward, marked his 6,000th hour and 1,000,000th mile in the air.

Mrs. Evelyn Burleson of Albany, Ore., flies non-stop from Vancouver, B. C. to Tiajuana, Mexico, in 16½ hrs. in a 1940 Taylorcraft with 65 hp. Lycoming engine.

John A. Steele, service engineer for Pan American, is temporarily assigned as operations manager of new Pan American Air Ferry Service.

Merle J. Oelke, chief staff photographer for American Airlines, is named publicity director of the line's southeastern division.

Mahlon Gregg is appointed manager of the Rochester office of the Contract Distribution Division of OPM.

Frank Wallace resigns as manager of the Aircraft Parts Division of Harvey Machine Co., L. A.

V. A. Leach, president of Leach Relay Co., L. A., was fatally injured in an automobile accident.

Harlan A. Messner is appointed sales engineer by Ohio Crankshaft Co. and heads the West Coast office for sales and service of Tocco induction equipment.

Prof. George J. Higgins is promoted to professor and director of the Department of Aeronautical Engineering of the University of Detroit.

Bruce B. Prentice is promoted to engineer, aeronautics equipment division of General Electric, and **Kenneth K. Bowman** to assistant engineer.

C. P. Bulotti Machinery Co. is named exclusive agent for Kent-Owens Milling Machines in the San Francisco territory.

Fred C. Wood is appointed manager of the air conditioning department of York Ice Machinery Corp.

Earl C. Maund is placed in the Chicago office of Manning, Maxwell & Moore, in a sales and engineering capacity.

Carter Glass III enlists in the Air Corps as aviation cadet.

Harold M. Lochrane joins Kaydon Engineering Corp., in charge of methods and standards.

C. Y. Neff, service manager of Hewitt's Aircraft Products Div., returns from England where he made extensive studies of aircraft bullet-sealing fuel tanks.

Harlan H. Newell is elected treasurer and a director of Cleveland Automatic Machine Co.

George J. Haislmaier is appointed sales manager of the Contract Products Div. of Young Radiator Co.

E. V. Clark of Hughes Aircraft is appointeed to National Panel of Arbitrators of American Arbitration Association.

James H. Baldridge is named personnel director of Pennsylvania-Central Airlines.

OPERATORS CORNER

Feeder Feeler

Charging regular airline passenger rates for its service, State Airlines of Charlotte, N. C., a charter operator, is providing service between designated points on a nonscheduled basis. Even a 10 percent discount is given for round-trips between designated points.

Feeling that it has demonstrated the need for such service, and that scheduled airlines and the public have benefited by feeding hitherto untouched sources of traffic into the airlines and providing better connections between the airlines in the area, State Airlines is presenting an application to the CAB for certification to operate on a scheduled basis as a feeder and connecting line.

Air Defense Reserve

The West Virginia Board of Aeronautics is organizing pilots, certificated mechanics and airport personnel of its state into a "West Virginia Air Defense Reserve."

Patterned along the lines of similar organizations now in existence in other states, its purpose is to coordinate all private and nonscheduled flying activities in the state with the national defense program, to assist in combating subversive activities, to prevent violations of CAA and national defense regulations and to aid in procuring applicants for the air forces.

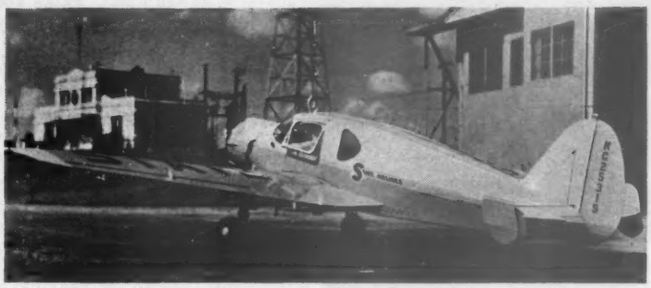
The plan provides a means for private and nonscheduled commercial pilots to contribute to the national defense. On the other hand, it offers an opportunity for private flyers to continue flying in the present emergency and also gives them a priority status whereby it will be easier to obtain airplane and engine parts. A comprehensive training program is contemplated and a temporary organization is being set up pending the establishment of the permanent reserve organization.

New Kansas City Airport

The City Council of Kansas City has moved to acquire 751 acres of land at Grandview, Mo., 35 minutes south of the downtown district, for the purpose of constructing an auxiliary field to relieve air traffic congestion at the existing municipal airport.

Tentative plans call for the construction of three 1000-foot runways at the start, although the master plan of the airport provides for 10,000-ft. runways, which would require taking up options on additional acreage.

Meanwhile, the $2,000,000 Fairfax Airport expansion project, adjacent to the new North American bomber assembly plant, is rapidly nearing completion. Part of the new construction is already in use by Army and Navy planes based at Fairfax.



One of the 2-passenger Bellancas used by State Airlines providing feeder and connecting services between points in the Carolinas.

FDR Favors DC To Rule Airport

President Roosevelt has indirectly intervened in the squabble between District of Columbia authorities and those of Virginia, over jurisdiction of the new Washington National Airport.

In a letter to Rep. Jack Nichols, D., of Oklahoma, who with Senator McCarran, D., Nevada, has legislation pending to give the District final control over the airport area, the President stated that he saw "many advantages" in giving the District such control. Observers believe the President's influence will settle the matter in favor of the District.

Uncertainty of jurisdiction is causing trouble for the management of the airlines and has prevented the serving of liquors in the terminal restaurant.

New Airport for Atlanta

The new Atlanta-Marietta airport, 14 mi. north of Atlanta, will soon be ready for use. January 1 has been announced as the approximate date of completion by Georgia Air Service, Atlanta concern which has leased commercial operations of the field.

Flyers have been confronted with the problem of traffic congestion at Atlanta's present municipal airport, but the new Atlanta-Marietta airport will provide adequate facilities of every type to relieve the congestion. Repair, overhaul and storage facilities will be offered by Georgia Air Service, which also operates an Air Corps Training School at Bennettsville, S. C. Cody Laird and Ralph Lockwood are the operators of the service.

The airport occupies a 563 acre tract and will have three runways, 500 ft. wide and 4,500 ft. long. Present plans call for later extension to 6,000 ft.

University of California won the championship trophy at the 1941 annual Pacific Coast Intercollegiate Air Meet, sponsored jointly by the Los Angeles Chamber of Commerce and the Interstate Aircraft & Engineering Corp., held on Los Angeles Airport, Nov. 8th. Interstate Cadet training planes were used by all contestants for events which included paper cutting, bomb dropping, and spot landing. Four-pilot teams were entered by University of California, University of Southern California, Stanford, and San Jose State College. A majority of contestants were graduates of the C.P.T.P.

Prep School for Cadets

To help meet the urgent demand for more Army Flying Cadets, the New York Y.M.C.A Schools have announced a preparatory course for the Army Air Corp Flying Cadet educational examination to begin at the 5 West 63rd Street branch November 17.

The intensive course is designed to assist young men who lack two years of college work and must take a stiff educational exam in lieu thereof. Applications to the Army should be submitted and physical examinations undergone if possible before enrolling in the course.

The class meets Mondays, Wednesdays and Fridays from 6:30 to 9:30 p.m. and prepares for the examination to be held in February, 1942. Tuition for the course is $30.

It Doesn't Always Pay

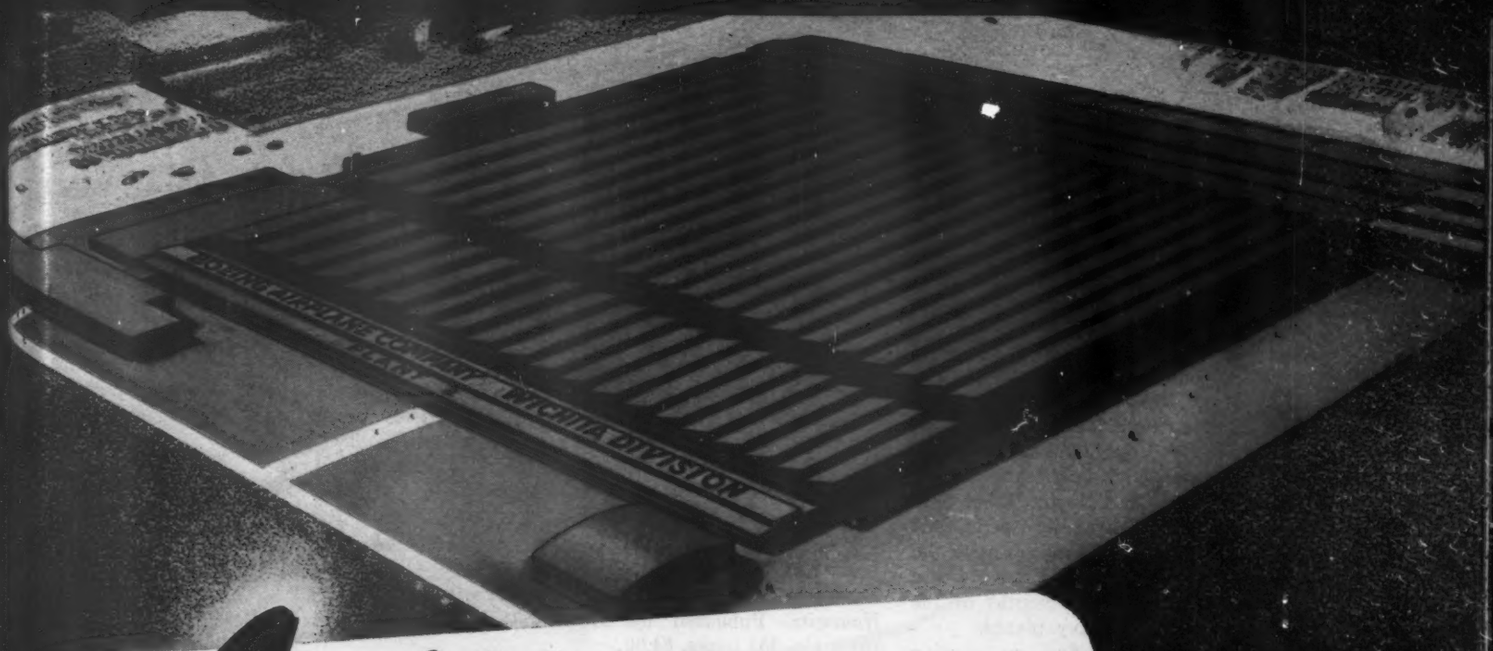
A member of the Civil Aeronautics Board recently wrote to interested persons that the Board has to consider costs when passing on applications for new certificates and extensions of lines. He said there is a wide misconception that airlines are set up at their own expense and their own risk, without cost to the government. Air mail compensation is required to keep most airlines in operation, he wrote, and prospective benefits to the public must be weighed against prospective costs to the public.

Purchase of 54 acres of property adjacent to Los Angeles Metropolitan Airport by the Timm Aircraft Corp. will make possible a substantial expansion program to speed production of Timm plastic-plywood trainer and aircraft component parts of both plastic plywood and metal construction, being manufactured under sub-contract for other Southern California aircraft builders. Timm plans construction of a private landing runway and substantial extension of present factory buildings.

Air-Rail Hookup

Transcontinental and Western Air is in process of filing an application with CAB for a certificate to operate an airline between New York and Boston via New Haven and Worcester, Massachusetts. The company announces its intention to establish a new airline corporation in conjunction with the New York, New Haven, and Hartford Railroad Company. This proposed action has been approved by the U. S. District Court at New Haven. The new Company to be known as "TWA-New England, Inc." will be held by TWA with 55 percent of the stock, and it will be managed by the airline. The railroad and TWA plan to coordinate their facilities for service on combination tickets.

Minimum wage of 50 cents has been established for manufacture of so-called Class II aircraft parts and accessories done on government contracts; determination was made under the Walsh-Healey Act.



Action IN THE MIDWEST

BOEING'S WICHITA DIVISION CONTINUES TO SET DEFENSE PRODUCTION RECORDS!

FORTRESS WING TIPS FROM THE WICHITA PRODUCTION LINE

PRESS BRAKES FORM A LINK IN THE CHAIN OF PRODUCTION

MEN AND MACHINES UNITE TO BUILD GREAT BOMBERS

BOEING'S WICHITA DIVISION, first to complete 2,000 airplanes for the U. S. Army and Navy under the national defense program, is keeping ahead of delivery dates on primary trainers, while contributing to the Seattle production of 4-engine Flying Fortresses. Now this midwestern "Arsenal of Democracy" is being extensively enlarged by the construction of a new Wichita Plant 2 which will equal the size and productive capacity of Boeing's great Flying Fortress factory in Seattle. Large completed sections of this new plant are already in full production for national defense.

ABOVE: THE 2000TH PRIMARY TRAINER WAS DELIVERED AUGUST 27, 1941

BELOW: THE "INSIDE STORY" OF A FLYING FORTRESS WING

Boeing

AIRPLANE COMPANY

Seattle, Washington
Wichita, Kansas
Vancouver, B. C.

Recent Books

Air Base, *by Boone T. Guyton.* Published by Whittlesey House, McGraw-Hill Book Co., New York. 295 pages, $2.50.

This is one of the most interesting books about Navy flying that we have seen in a long time. The author is now test pilot for Vought-Sikorsky. After he left Pensacola a few years ago he was assigned to the North Island base at San Diego, where he spent four years when he was not at sea with the carriers. Then he went to France where he served the first six months of the present war testing navy planes.

In the Navy he flew in a dive bomber squadron and his book describes the life and activities involved in such work. There is a vast amount of informal, behind-the-scenes Navy talk which has not been previously told. The book will interest Navy men, as well as the thousands of young men today who hope to become Navy pilots.

Machine Shop—Theory and Practice, *by Albert Wagener and Harlan Arthur.* Published by D. Van Nostrand Co., New York. 306 pages. Paper bound, $1.60. Cloth bound, $2.28.

Written for beginners in machine shop work, this book devotes 19 chapters to all phases of such work. The page size is large, giving ample room for scores of excellent illustrations. The authors are with the Henry Ford Trade School and the Ford Apprentice School.

Aircraft Layout and Detail Design, *by Newton H. Anderson.* Published by McGraw-Hill Book Co., New York. 306 pages, $3.

The author is an engineer at the Douglas Aircraft Co. and has been cited as "one of the company's most experienced and highly skilled engineers." The book was written for two groups of men: those who already understand something of aircraft drafting and who want to prepare themselves for better jobs in layout and design work; and for men who are experienced in design or manufacture outside airplane work and who want to adapt their experience or training to aeronautical work.

The book covers three main subjects with which every good aircraft layout draftsman must be familiar: descriptive geometry, detail design, fitting analysis. Chapter headings are: requirements for a good layout, descriptive geometry for aircraft layout, airfoils, general design considerations, connections, fabrication methods, fundamental principles of fitting analysis, strength calculations for riveted and bolted joints, bending and torsional stresses, strength of struts and columns, design of thin web beams, and an Appendix containing useful tables.

Aircraft plants today are filled with young men who have managed to get their first job but who are searching desperately for ways in which they can climb the ladder to a better job in aviation. This practical book will be of help to all those eager to learn more about layout and detail design.

Dynamic Meteorology. *By Bernhard Haurwitz.* Published by McGraw-Hill Book Co. 365 pages, $4.00.

Much of the progress of meteorology in recent years has been due to the application of the laws of thermodynamics and hydrodynamics to the study of the atmosphere and its motions. In this book is presented a concise treatment of the laws that operate in the atmosphere. It stresses those results of dynamic meteorology which are of importance to the practical forecaster.

Some preliminary training in general meteorology will facilitate study of the book and a good mathematical background is essential, although the mathematical technique has been kept as simple as possible. Recent advances which have led to airmass analysis, frontal and isentropic analysis and the wave theory of cyclones have been included.

"We Made a Mistake," *by Lucien Zacharoff.* Published by D. Appleton-Century, New York, 213 pages, $2.

This book is about Russia and the title is a quotation from Hitler who said: "We made a mistake about one thing—we did not know how gigantic the preparations of this opponent against Germany had been."

Zacharoff has written a heartening book because he reveals the thorough preparations Russia has been making for a number of years. Her collection of airplanes, tanks, mechanized equipment, warships and submarines, as well as the training of civilians for war duty make an impressive story. Most of us, who expected that Russia would be another pushover for Hitler's hoards, have had a constant series of surprises. This book tells why the Russians have done so well.

One of the most interesting parts of the book deals with guerilla troops, encirclement and how civilians have been trained for war work. The book is well written, many personal stories are interestingly told, and hundreds of facts and figures back up the author's contention that the seeds of Hitler's defeat have already been sown in Russia. It is also emphasized that U.S. airplanes and other combat equipment are badly needed.

Zacharoff is an associate editor of Aircraft Publications and has written articles for Aviation and a number of leading newspapers.

Air Mail Payment and the Government. *By F. A. Spencer.* Published by The Brookings Institution. 402 pages, $3.00.

The author of this book, unlike those of many similar works, has actively participated in the aviation industry for some years. He has conducted an authoritative analysis of problems in that area, so inadequately explored, where economic and administrative issues are closely intertwined—a field whose importance is increasing with the addition of more and more regulatory agencies in the federal government.

He has traced from the beginning the issues and problems encountered in determining the amounts of remuneration going to the airlines for carrying the mail, analyzing all the decisions of the Civil Aeronautics Board and predecessor agencies dealing with adjustment of air mail compensation. The text also includes a discussion of what has been the most vexing problem of rate regulation—that of the measuring rod for profits, commonly known as the rate base.

A Pilot's Meteorology. *By Charles Greham Halpine.* Published by D. Van Nostrand Company, Inc. 220 pages, $2.50.

Though dealing with a highly technical subject, this compact volume makes easy reading for the students and "just average pilots" who do not need to master professional meteorology. The author has sought to reduce to simple terms the basic truths and principles of meteorology, without the mathmatical formulas, complicated diagrams, advanced physics and differential equations, to the end that those who fly the airways for pleasure and business may be better and safer pilots.

The author is a retired Lieutenant Commander of the U.S. Navy, and is now a member of the staff of the Weems System of Navigation and Ground School Instructor at the University of Maryland.

(*More Books on page 196*)

HERE'S ALL-PURPOSE PRINT MAKING IN ONE COMPACT UNIT

BASIC FACTS ABOUT PRINT MAKING YOU SHOULD KNOW

AN OZALID TRANSPARENT DUPLICATE CAN BE CHANGED AND CORRECTIONS ADDED TO THE SAME PRINT IN EITHER PENCIL OR INK. Subsequent prints will show all the changes . . . the original remaining intact!

Changes and additions are made quickly on a transparent duplicate either by using Ozalid Corrector Fluid for incidental or scattered changes, or the Ozalid "block-out" method for major corrections. Both eliminate the necessity of complete retracing and provide short cuts in drafting.

The corrected transparent duplicate produces prints at a speed 3 to 5 times faster than is possible with a Van Dyke negative. The prints are permanent . . . free of distortion . . . and the changes true-to-scale.

Ozalid transparent materials include a variety of papers, cloth and foils, any of which may be used as a duplicate original for making subsequent work prints. This enables you to file your valuable originals and keep them safe from wear and tear.

This is the second of a series of facts on modern print making. Watch for Fact No. 3.

FOR A COMPLETE, all-purpose method of making prints—and today the demand is for a service more versatile than blue-printing—the Ozalid Process offers a full line of sensitized materials and Whiteprint machines that combine exposure and dry development in one compact unit.

By using the Ozalid Process, you get—in a matter of seconds—positive-type whiteprints of engineering drawings or anything written, typewritten or drawn on reasonably translucent paper . . . prints that are true-to-scale, durable, and will not wrinkle or curl.

With this all-purpose process you get . . . SUCH STANDARD MATERIALS as papers producing black, blue or maroon lines on a white background . . . transparent materials including transparent papers, cloth and foils . . . SUCH SPECIALTIES as paper laminated on cloth . . . airmail weight paper . . . paper coated on both sides . . . opaque cloth . . . correctors for eradicating line detail . . . SUCH SERVICE as fast—economical—print making.

Ozalid whiteprints are made simply by placing the original on a piece of Ozalid sensitized material and feeding both into the machine. Exposure and dry development are combined in the machine to produce a finished print that is dry, ready for immediate use. Ozalid transparent duplicates are produced the same simple way.

Compare this quick, complete process with the indirect way of making blue prints which requires washing—fixing—drying and trimming. Eliminate unnecessary production tie-ups by installing an Ozalid machine. Write for illustrated literature today.

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NECESSITY BROUGHT ABOUT BY WORLD WAR NUMBER 1 FURNISHES PROVING GROUND for NO-OX-ID

● After World War Number 1, NO-OX-ID Rust Preventive was used successfully for treating inside as well as outside of airplane engines for preservation in long time storage. After 15 years these engines were usable.

● NO-OX-ID "EEE" (Triple E) is the resulting product of constant research keeping pace with changing developments in engines.

● NO-OX-ID in its chemical structure and consistency has a proven record in aeronautics for use in maintenance and preservation. It is a well-known, accepted preservation material in industry and designed for specific purposes. Write for complete information.

DEARBORN CHEMICAL COMPANY

Dept. Q, 310 S. Michigan, Chicago

NO-OX-ID
IRON RUST
The Original Rust Preventive

Mobile Shops

(*Continued from page 63*)

and observation squadrons. In order to supply these squadrons with complete airplanes and still have a reserve pool of ships on hand, it maintains an Air Park, comprising enough commissioned airplanes to fill the replacement needs of the four combat groups. When the supply in the pool begins to get low more ships are dispatched from the larger air depots located back in the zone of the interior.

Under many conditions of combat it is impossible for this mobile depot to carry on all types of maintenance. Under ideal conditions it can maintain the whole airplane including the engine and instruments. However in an extremely active battle, either on the offensive or defensive, the amount of work carried on is dictated by the situation. Governed by the fundamental rule of war that the objective is the ultimate goal at any cost, equipment is abandoned if time does not allow its repair. In the offensive under these conditions, damaged equipment that requires too much time to service on the spot, is shipped back to the maintenance depot in the zone of the interior to be repaired. In the defensive under these conditions it is left for the enemy, being destroyed whenever possible.

When the depot has been assigned to a certain area in which to operate, and it is obvious that it will be there for some time, it "digs in" and all of the mobile equipment is temporarily fixed in place with the portable hangars and shop buildings erected. Large lathes and other machines more easily operated in large areas, are placed on cement foundations erected on the spot. Cement floors are also laid and the equipment is taken out of the trucks and trailers and placed in the most efficient arrangement. Fields are leveled to make better airports and in general the base is made as permanent as possible. Here again the extent of the permanency is governed by the situation on hand and it is up to the judgment of the commanding officer to decide just how far they will go.

However it is not always possible to remain in one place for rather long periods of time, in fact they may have but a couple of weeks in which to operate. In this case the work is carried on right in the trucks, which are equipped to function much like a side show does when a circus is on the road. In this case the trucks form the main units of the base with temporary jacks, lifts, work stands and such equipment taken out when it is needed.

When a crash has been reported to the mobile depot group, a reconnaissance is made immediately to determine the extent of the damage and the accessibility of the airplane for repair. To facilitate making these observations as rapidly as possible, the unit has been furnished with numerous types of transportation ranging from motorcycles to Basic Combat type airplanes which fly over the scene of the wreck. When it is possible, equipment is transported by land, water or air to the damaged airplane along with the necessary men to do the repairing. If this is not practical, however, the ship is brought back to the mobile depot base and there serviced.

The Air Depot Group is commanded by a Colonel who has under him officers and enlisted men. Unlike the depots in the zone of the interior, no civil service personnel are employed. Included in the men assigned to the depot group are detachments from the Medical Corps, Ordnance Corps, Signal Corps, Quartermaster Corps, Chemical Warfare Service and the Corps of Engineers. These troops are necessary to carry out all of the auxiliary functions which assist the men from the Air Corps, which form the basis, in maintaining the airplanes. It is the number of troops from these assigned units that are varied to meet the situation prescribed by the section of the country in which the depot is going to operate. In numerous situations the Navy may be called upon to furnish transportation over water, or Marines to overcome resistance, any or all of which may be made an integral part of the Mobile Depot.

The unit is headed by a headquarters squadron. Under this come the repair squadrons and the supply squadrons, which, together with the normal component of assigned troops, totals 16 officers and 160 enlisted men, practically all of which have specialists' ratings. Included in the equipment is all of the necessary machinery to carry out maintenance work on the airplane, engine and instruments. This means welding and riveting apparatus, material for jigs, jacks, lifts, lathes, grinders, honers, instrument testing apparatus etc. Being prepared for large scale operations the mobile depot has as part of its assigned equipment such machines as a steam shovel, a steam roller, bulldozers, numerous heavy and light trucks, portable hangars, shops and warehouses, and six airplanes.

It is upon these units that the mechanical efficiency of the Air Corps is now resting. They are a fundamental unit of the fighting force designed to keep pace with the fast moving modern war, but above all to "Keep 'em Flying".

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S.A.E. Maintenance

(Continued from page 113)

duction which has been made during the past year. Space in the display was sold out far in advance of the meeting and a great deal of effort had been devoted to the preparation of working exhibits which were arranged to demonstrate the functioning of hydraulic and electric units, Magnaflux testing, special tools and inspection equipment, the new Ryan ball and socket exhaust manifolding system, etc. Exhibitors included were: American Bosch Corp., ignition and electrical equipment; Bendix Aviation, Ltd., hydraulic and electrical parts and accessories; E. G. Budd Mfg. Co., welded stainless steel assemblies; The Cleveland Pneumatic Tool Co., hydraulic struts; Interstate Aircraft & Engineering Corp., hydraulic units and special accessories; Lamson & Sessions, screw products; Magnaflux Corp., magnaflux testing equipment; Menasco Manufacturing Company, hydraulic struts and parts; The National Screw and Manufacturing Company, screw products; Parker Appliance Company, aircraft plumbing; Purolator Products, special oil cleaners; Rohm & Haas, Plexiglas; Ryan Aeronautical Company, the patented Ryan ball and socket exhaust manifold system; Simmonds Aerocessories, aircraft accessories and electrical products; Solar Aircraft Company, stainless steel exhaust manifolds; Swedlow Aeroplastics Corp., plastic aircraft parts; Turco Products, Inc., special aviation cleaning compounds; and Wright Aeronautical Corp., a Wright Cyclone engine.

All four Pacific Coast Sections of the S.A.E. cooperated with the national S.A.E. organization under the personal supervision of Mac Short, chairman of the Southern California Section of the S.A.E., in staging this meeting. Robert Insley, Menasco Manufacturing Company, was general chairman of the meeting, and J. H. Kindelberger, North American Aviation, acted as chairman of the Aircraft Engineering Display. As usual, the closing event was a banquet and grand ball held on Saturday evening. Arrangements for this event were handled by Fred C. Patton, all tickets being sold out more than a week in advance. Session chairmen during the meeting included: H. H. MacMahon, chief engineer, Menasco Manufacturing Company; Gunnar Edenquist, sales engineer, Kinner Motors, Inc.; Henry J. E. Reid, N.A.C.A.; John K. Northrop, president Northrop Aircraft, Inc.; Mac Short, vice president, Vega Airplane Co.; Carl B. Squier, vice pres. Lockheed Aircraft Corp.; and Stanley A. Bell, chief engineer, Hughes Aircraft Co.

The importance of standardization to expansion of our production effort was emphasized by Pres. A. T. Colwell, in opening the meeting. Mac Short then introduced Jack Gray, Aeronautical Chamber of Commerce, who gave a heartening report on success of our production expansion effort, forecasting a total output for 1941 of more than 18,000 planes, as compared with only 2,400 in 1939, and about 6,000 in 1940.

One of the highlights of the meeting was presentation of the Wright Brothers Medal to C. L. Johnson, Lockheed Aircraft Corp. This medal is awarded annually to the S.A.E. member con-

Sam Breder, Equipment Sales Mgr. for Ryan, is shown at the Ryan booth.

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The Library consists of handbooks, instruction outlines, reprints of engineering articles, design data, safety folders and even a monthly "how-to-do-it" periodical, OXY-ACETYLENE TIPS. Among the many subjects covered are: oxy-acetylene welding, flame-hardening, flame-priming, flame-gouging, shape-cutting, stack-cutting, and hard-facing.

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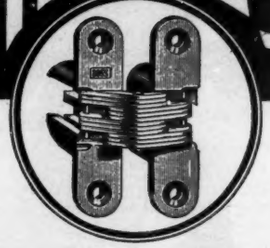

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Swedlow Aeroplastics Corp. had this exhibition of its products.

Turco Products presented a number of its specialized cleaning compounds for aviation purposes.

tributing the paper judged most valuable of the year to aircraft research, and was based on a paper presented by Johnson at the Detroit meeting in January, 1940.

Time is the biggest bottleneck of all, and morale is the hidden ingredient that will win the battle of production in defense of democracy, said T. P. Wright, OPM, in giving an account of our production position at the Friday evening session. Former vice president in charge of engineering for the Curtiss-Wright Corp., and now serving as chief aircraft production consultant to the OPM, Wright is the best qualified man in America to evaluate our present place in the production effort. His words were cheering. Acknowledging that there had been some cause for criticism a year ago, Wright outlined the progress made since that time and concluded that results were more than satisfactory. He stated that our rate of production expansion in the past year had exceeded anything done at any time either in Germany or England. For the future there is now every assurance that the difficulties still hindering aircraft production will have been surmounted before next summer, giving us a smooth flowing aircraft production schedule exceeding anything that would have been believed possible as recently as a year ago.

A detailed analysis of the development of Blitzkrieg tactics was given at this same session by A. T. Colwell, S.A.E. president, together with a formula for stopping Blitzkrieg. Colwell showed how the Germans have taken advantage of the internal combustion engine to develop a new technique in applying the same principles of warfare. This use of motorized armored equipment, both on the ground and in the air, has succeeded because it was opposed by old armies. Perfection of our production capacity to give equality of armament and mechanization to the forces opposing Hitler's panzer forces will stop this world threat.

Although war was the shadow which overhung the entire meeting and injected itself into most of the discussions, there was one paper which broke away completely from the military motif. This was the discussion by W. B. Stout of his work in perfecting a new type light airplane and engine, designed for the after-the-war market. A capacity crowd turned out to hear the inimitable "Bill" Stout and they were not disappointed. His presentation was as entertaining as it was educational. And the speaker was mobbed at the conclusion of his talk by inquisitive engineers who wanted to get their hands on the multi-piece crankshaft, centrifugally cast steel cylinder, and other engine parts which Stout had brought along for their examination.

While Stout did not claim that his work was yet assured of success, admitting that much testing and experimentation remained, yet there was in his report the feeling that a whole new field had been opened for expansion of lightplane design, as well as for the application of new engineering ideas both to airplane and engine development. Starting with an analysis of the light airplane for a mass market, Stout carried through step by step to the detailed description of his cantilever, high wing, two place airplane of stainless steel construction, with four wheel landing gear, and a 120 hp. engine of conventional four-cylinder flat arrangement, but of radical structural design.

In development of his airplane design Stout has worked with stainless steel with the thought that perfection of its application to a very small plane would make it easy to apply this material to larger designs where thicker sections can be employed. With a skin surface of only .006 thickness the wing skin is kept from wrinkling and "oil canning" by putting it under internal air pressure

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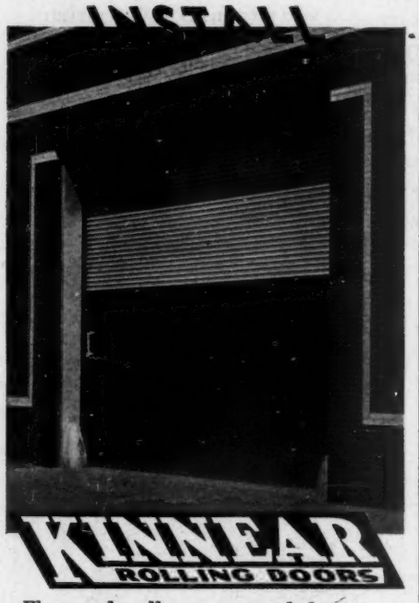

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provided by means of an air scoop. This practice adds materially to the structural strength of the wing, especially in torsion. To make satisfactory use of stainless steel material Stout found it necessary to make basic changes in the composition of the metal, resulting in a more ductile product. In order to do acceptable spot welding a research program was conducted with the result that successful welds are being made of .005 material to .040 thickness. This requires control of the time of weld to such a fine point that on some welds only 1/240th part of a cycle is used (60 cycle current).

Stout's new engine is designed around a novel crankshaft developed by Jules Dusevoir, in which the crank pins and crank arms are separate parts bolted together with the use of concentric semicircular serrations on the pin and crank arm joint faces. The result is a shaft which is more precise in final alignment, stronger and cheaper than the standard one-piece forged shaft. Stout believes that this crankshaft design will be found of advantage for shafts of all types and sizes. It permits of cheap production practices, a high degree of parts standardization, and the use of materials of varying qualities for the different shaft components.

Most important result of the use of this multi-piece shaft is that it permits use of a one-piece crankcase and one piece connecting rods, standard roller bearings throughout, and otherwise simplifies engine design and construction. Cylinder cost has been radically reduced through use of centrifugally cast steel cylinder barrels. The present engine weighs 120 lbs., develops 120 hp. and is relatively cheap to build. Stout admitted that the cost and weight of the engine accessories was still an unsolved problem but he hoped for progress on this point. A novel engineering feature of the new engine is provision of a two-speed gear drive to the propeller, permitting the engine to turn up 3600 rpm. on take-off to 2500 rpm. at the propeller shaft. When the propeller reaches its speed of 2500 rpm. the gear is automatically shifted into direct drive. This development will be watched with considerable interest. Together with new controllable pitch propellers recently developed for light aircraft it may well provide a remarkable extension in the present range of lightplane performance.

Production papers were interspersed liberally through the meeting and brought much new information to the attention of those in attendance. One of the most interesting papers was that on the new du Pont explosive rivet, prepared by L. A. Burrows and D. L. Lewis, Jr., and presented by Lewis. This rivet has been perfected, both in design and manufacture, to the point where all corrosion difficulties have been eliminated, tolerances in dimensions and explosive charge are being held to extremely close limits, and the strength of explosively riveted joints is closely comparable to joints with standard driven rivets. In Germany the explosive rivet is supplanting driven rivets to a considerable extent, partially due to the labor saving resulting from elimination of the bucker-up. Originally developed as a device to do blind riveting not possible by any other method, the over-all cost of driving the du Pont rivet has been brought to an average as low as 7 cents per rivet against 5 cents for the driven rivet, and there is some hope that this may be further reduced to make the explosive rivet directly competitive with driven rivets on a cost basis.

Of equal interest among production papers was the description of "Illustrated Production Breakdown" by George Tharratt, formerly with Douglas Aircraft Company and recently

Bendix Aviation Ltd. had this attractive display for visiting engineers to inspect.

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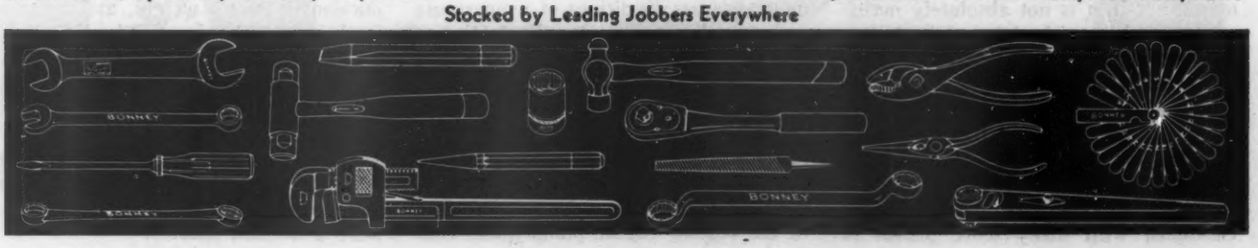

appointed Chief Engineer of Adel Precision Products Corp. Tharratt showed, by means of liberal use of slides and through a humorous off-the-cuff presentation, how substitution of perspective drawings and sketches for blueprints on the final production line has greatly simplified assembly problems and saved hundreds of engineering man hours in liaison work. Such drawings are now being widely applied, by many aircraft companies, to engineering and maintenance work as well as to production. One of the chief problems has been to find and train men who were properly qualified both as engineers and illustrators. This is now being solved through use of engineer-illustrators as lead men with each illustration group, using a staff of men who are selected from among commercial artists and art students.

Sweet music to the ears of aircraft men was the multi-authored paper on the lessons learned by the Briggs Mfg. Co. in getting into production on aircraft assemblies. Prepared by H. H. Budds, F. W. Hofman, E. E. Lundberg, H. T. Platz, and H. J. Roesch, all of the Briggs Mfg. Co., this paper was presented by Joseph Geschelin, editor of Automotive Industries. The authors freely admit that automobile men have learned much about quantity production of aircraft from the aircraft people, and still have much to learn. Much progress is being made in the development of high speed assembly methods. One explanation for any lack of cooperation which may have been charged against aircraft people is that their key personnel has been spread so thin by the tremendous expansion program of the past year that they simply do not have time for any problems but their own. One point where much can be accomplished is in the training of new workers in "attitude". This is interpreted as an effort to show each worker how important his job is, no matter how small it may seem to him, to the success of the complete effort.

Much progress in development of standardization was reported by C. E. Stryker, of the OPM. While there is still much to be done it was emphasized by the speaker that our production effort in the present crisis is so great and the need for maximum output now is so immediate that we must test all proposed standards by the maxim: "If it is not absolutely necessary that the standard be adopted then it is absolutely necessary that it not be adopted." Great strides are being made and loopholes in the standardization program are steadily being plugged. For example, the U. S. Army Air Corps uses more than 80 different sizes of airplane tires, whereas the Germans, with many more planes in service, use only 25 different sizes. Standardization is also as vital to successful maintenance in the field as it is to speed-up of manufacturing operations.

Establishment of engineering liaison groups as an aid to production control was outlined by Donald Kudlich, Wright Aeronautical Corp. Such liaison engineers free the project engineer for concentration on design work. By working more closely with production it is possible to make necessary changes in specifications "on the spot" and so materially speed production and catch troubles long before the final assembly stage, when delays would be more costly.

Airplane Quality Control, presented by J. W. Dunn, Curtiss-Wright Corp., explained how inspection methods can be streamlined to speed production, increase the proportion of salvaged parts, and maintain the quality of the product.

One of the most interesting papers in this group was on "Two-Speed Supercharger Drives," by F. M. Kincaid, Jr., Wright Aeronautical Corp. With the help of colored slides showing detailed cross-sections of the supercharger drives under consideration, Kincaid laid bare the secrets of two speed drives developed by the Wright company, Bristol and Rolls-Royce, in England, and Junkers and Mercedes-Benz, in Germany. While some of the foreign systems possess novel and interesting features, the American drives were shown to be equally rugged, much more compact, and of lighter weight, averaging only about one-half the weight of equivalent European drives. Development in this field has been rapid and satisfactory, but the recent perfection of two-stage superchargers, especially of the American turbo-supercharger, is threatening to supplant the two-speed drive, and in any case may be widely used to supplement the variable ratio drives.

In the field of research interest was largely concentrated on problems of high-altitude flight. The immediate military need to send our fighter and bomber planes into the thin air of the stratosphere has put such research work under the most intense pressure and results of the most far-reaching importance are already being attained. Illustrated with high-speed photographs of vapor formation in a tank operating under various conditions of temperature and altitude, a paper on "Fuel Feed at High Altitude" by W. H. Curtis and R. R. Curtis, Thompson Products, Inc., was presented by W. H. Curtis. This paper outlined the rapid progress that has been made in applying centrifugal pumps mounted directly in the fuel tank, as booster pumps to supply fuel to the regular engine pump under conditions that would normally produce vapor lock in the fuel lines.

"Icing Problems in Aircraft Engine Induction Systems" by L. B. Kimball, National Bureau of Standards, summarized the results of an extensive research program. Similar laboratory work by Pratt & Whitney Aircraft was told in the course of prepared discussion on the Kimball paper, presented by Victor J. Skoglund. While both authors admitted that much work remains to be done, there is now enough evidence at hand to justify the belief that complete solution of all icing problems is at hand.

Aircraft Carburetor Air Scoops and Their Effect on Fuel-Air Metering in Flight, was presented by F. C. Mock, Bendix Aviation Corp. This is a subject on which many may have thought that there was little to know and that had long since been learned. Actually, as the author pointed out, and demonstrated with moving pictures of air flow in various air scoops, very little is known on the subject. We know that certain scoops work satisfactorily, but we are just beginning to find out why. Each new design presents new problems which are still being solved by cut and try methods on the basis of flight tests. We still are not sure where the air scoop should be located, let alone just what form it should have. But the present research work is a long step in the direction of complete solution of this particular phase of design work.

An annual report on the progress of the C.F.R. Committee on its investigation of vapor lock problems was given by Dr. O. C. Bridgeman. The vast amount of research done by this committee is now proving invaluable as a reservoir of knowledge on which many industry engineers are drawing for a solution of some of their immediate difficulties.

Final paper of the meeting, entitled "Will Accessories Impede our Payload" was given by L. R. Hackney, Lockheed Aircraft Corp., who has been very active in organization of weight control work among aircraft engineers. While the title might indicate an attitude of antagonism towards the accessory people, the opposite is actually the case. Through cooperation among aircraft designers and accessory engineers much progress is being made on reduction of excess weight, and progress is being made in standardizing the evaluation of competing accessories, taking full account of qualities of performance, reliability, and serviceability as well as of weight. The paper provoked a very spirited discussion, illustrating the interest which exists in this subject. On the whole, the meetings were a decided success.

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Making Aviation History

BELL AIRCRAFT CORPORATION

Bell Aircraft Ordnance Division **BUFFALO AND NIAGARA FALLS, N. Y.**

Mass Maintenance Methods

(*Continued from page 81*)

We believe the most important factor in maintenance work is to appreciate the importance of good shop equipment, properly maintained. No amount of skill and ingenuity, or experience, can replace the proper tools needed to do a job. And no other qualities can make up for the failure to maintain tools in perfect order and cleanliness. We make cleanliness a fetish around our shops and hangars. Every item of equipment must be clean and in its place as though for dress inspection unless it is actually in use. There is no other way of making sure that the equipment will be available and in shape when needed. So far as possible we eliminate the practice of storing tools out of sight and tossed indiscriminately in drawers or boxes. We believe that polished tools neatly arranged on benches or tool boards do much to stimulate the morale of the individual mechanic and give the entire shop a degree of pride in its work.

To have pride in machines and equipment it is necessary first to have the equipment. There are very few short cuts to proper maintenance. The factories which build our planes, engines, and accessories are all splendidly supplied with special machines and equipment to do the job and so must we be if we are to maintain the planes and engines. We have gone right down the line and installed the finest hand tools, bench tools, shop machines, special parts stands and racks, aligning stands, special tools such as valve grinders and cylinder grinders, cleaning equipment, etc.

And we have provided clean, light, airy shops in which to use this equipment. Special attention has been given to workers' benches, outlets for water, air and electricity, and all other factors which combine to make a shop neat and efficient instead of cluttered and untidy.

Finally, there is no way to eliminate the need for properly trained men of the right type. We are fortunate in having a connection with the Curtiss-Wright Technical Institute. This has made it possible for us to obtain men whose qualifications and degree of training are particularly well known to us. Almost every man in our organization is a graduate of the Curtiss-Wright Technical Institute or has received special training to complete his educational background.

Our shops are separated by a distance of 50 miles, but we operate them as one organization. Plant No. 1 is located on Grand Central Air Terminal, Glendale, and does all types of maintenance work, airline, factory, private and military. We are doing an average of one complete engine overhaul job a day in this plant. Plant No. 2 is located at the Cal-Aero training center in Ontario, about 50 miles east of Glendale. Here we turn out an average of two complete engine overhaul jobs daily. Although we can interchange work to some extent between the two shops, most of the work at Ontario is on the training engines operated there, Lycoming R-630-11 model. We also handle airplane service and maintenance covering a total of 256 airplanes which are flying an average of 5 hrs. per day, for a total flying time of more than 1250 hrs. daily. Training planes are given a complete overhaul every 1,500 hrs. and training engines are overhauled every 540 hrs. We do a complete overhaul on the Lycoming engine in an average of about 106 man-hours.

We were fortunate in having operated Plant 1, at Glendale, for almost eight years before it became necessary to establish the Ontario maintenance base. By using the parent shop as a model we were able to lay out an ideal engine maintenance plant, putting into it all the features we had been wanting in the original base. Then we were able to select all our new men from the Curtiss-Wright Technical Institute and put them through a course of further training in Plant 1 before sending them out to work in the new maintenance shop, which was opened just this last June. In size the two shops are almost identical, each containing about 12,500 sq. ft. The Glendale shop is incorporated in a large hangar building and occupies an area measuring about 203 by 30 ft., plus office and storage rooms. At Ontario we erected a building with overall dimensions of about 210 by 125 ft. but in which the main overhaul shop was 210 by 31 ft. This arrangement gives us the straight-line flow of materials, as in a factory. The engine comes into the tear down department at one end of the shop, is disassembled, goes through the cleaning department, inspection department and then into the various individual shops before coming together at the assembly department at the far end of the line. The store room is located approximately opposite the center portion of the shop at both plants, making it most accessible for parts replacement work.

We act as distributors for Wright, Lycoming, Jacobs, and Menasco engines and parts, Holley carburetors and parts, Aero spark plugs, and as dealers for Pratt & Whitney and Continental engine parts, and Scintilla, Stromberg and Eclipse accessory parts, in addition to our service and maintenance work. Although our Ontario plant is now set up primarily for military work we can handle a wide range of commercial work on short notice. And at Glendale we are equipped to completely overhaul any engine from a 50 h.p. Lycoming to the Wright 3350 of 2,000 h.p.

We have made every effort to so systematize all work as to eliminate all possible overtime and every evidence of rush and hurry. We work on a straight 40 hr. week at Glendale and a 48 hr. week at Ontario, where training operations require a more intensive schedule. This is all day work. Although the airplane and engine routine maintenance is largely done at night in order to "Keep 'em Flying" we find that all engine overhaul work can best be done in the regular day shift. This is made possible by the fact that we have sufficient spare engines on hand to permit replacement of an engine for overhaul with one that has been overhauled, without loss of plane time.

Actual maintenance work at the two plants is done with relatively small but well-organized and highly-trained crews. At Glendale we have 30 men in the engine overhaul shop proper, and at Ontario there are 40 men in the engine shop. We have developed an organization over a period of years which makes it possible to maintain a very close control over all operations.

William "Bill" Clough is my direct assistant, supervising all purchasing and stores for all bases. Parts for all maintenance work are handled through him so that this important factor is concentrated at one point for ease of control.

At plant No. 2 all operations are in charge of Shop Sup't. H. J. Stewart, a Curtiss-Wright Tech. graduate of about 1929. At our Glendale plant we sub-divide the responsibility of the shop by having a shop Sup't., Harold Wolcott; Accessory Shop Sup't., Phil Oldberg; and with J. W. Horak in charge of hangars, engine test, and all of our servicing.

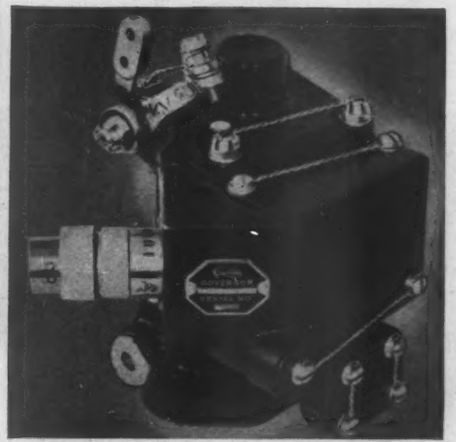
Airplane maintenance and servicing work at each base is done under the supervision of a maintenance chief. The Maintenance Chief at Ontario is Raymond M. Tonks, with four individual hangar chiefs, Glen O. Peterson, John Zauner, Harold E. Clements, and Nathan M. Hummer, under him. Each of these men has charge of all personnel in each hangar. Clarence B. Clark is maintenance chief at the Oxnard base, with Frank O. Behrman and C. N. Lamn as Hangar Chiefs. At Lancaster Harry J. Hemler is Maintenance Chief, with E. D. Masters as hangar chief.

Jim King operates as a technical inspector maintaining constant check on the condition of the airplanes and engines at all bases.

CURTISS HAWK, P-40, known to the British as the Tomahawk. This fast pursuit fighter, supplanting the P-36, also contains numerous parts which were machined from Synthane Bakelite-laminated.

Ounce by Ounce, Curtiss-Wright Sheds Weight with Synthane

CURTISS HAWK, P-36. Over forty Synthane parts were used in the Curtiss Electric Propeller alone, many more in the fuselage for holding "spaghetti", for cable guides, etc.



CURTISS GOVERNOR for starting the pitch control mechanism of a Curtiss Electric Propeller. Bushings and washers are made from Synthane.

EVERY ounce saved in aircraft construction means faster, farther flight or an opportunity for adding armor or armament. Wherever used, Synthane Bakelite-laminated, weighing only half as much as aluminum, shaves off vitally needed ounces. Synthane has more to recommend it than light weight. It is structurally strong, resists corrosion from water, aviation oils and gasoline. It is an excellent electrical insulator. And it is easy to machine, gaining valuable time in production. Synthane helps Curtiss-Wright and many others produce better planes faster.

SYNTHANE CORPORATION, OAKS, PA.

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Bakelite-laminated for

LIGHT WEIGHT with Structural Strength
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SYNTHANE TECHNICAL PLASTICS

SYNTHANE
Bakelite—laminated

SHEETS • RODS • TUBES • FABRICATED PARTS • SILENT STABILIZED GEAR MATERIAL

Materials to remember, specify and use for aircraft parts

Pan American

(*Continued from page 51*)

To understand the problem presented to the international air transport system, one must bear in mind the basic dissimilarities between transoceanic and orthodox landplane operations. The sheer size of an 84,000 pound aircraft, of course, scales up all the basic elements of maintenance procedures. The four Wright engines are larger than other power plants in transport service. The instrumentation is extensive and elaborate. Control cable, electric circuits and fuel lines each run into the thousands of feet. Control surface dimensions sound like span specifications for the small land transports. Many processes, such as cleaning, which are minor items in the maintenance of smaller aircraft, become major tasks on planes which have 65 windows, 9,000 square feet of upholstery material, a floor area equal to that of an 8-room house and external surfaces of a third of an acre.

There are 24 steps to the top of the main work stands. Mechanics always slide down the bannisters (originally designed as fire-escapes) to save time.

Every man working on the Clipper wears thin-soled "window-dresser shoes". This reduces tracked in dirt, and scratches on paint and metal.

Transoceanic flying boats operations also pose special maintenance problems not encountered in landplane work. Salt water greatly heightens exposure to corrosion. Long nonstop flight assignments increase exposure to wear and tear. To make sure that its "turn-around" method was adequate, Pan American Airways, drawing heavily on its experience in the Pacific and Caribbean, set up a procedure to perform as many as the 1500 items mentioned above, of inspection, maintenance and replacement, which must be completed before a Boeing-built Clipper is released for flight tests prior to a transoceanic crossing.

There is no method of attack, despite the special problems presented above, by which the "quick turn-around" was achieved for Pan American's transoceanic Clippers which cannot, in some degree, be applied to any maintenance procedure. The emphasis, of course, is on personnel—in hiring and training.

Naturally, like every other airline, Pan American Airways makes the greatest effort possible to get the best type of personnel available. Expansion of activities by no means allows one to adopt a policy of loosening requirements demanded of a man who does highly technical work. Just because more work has to be done is no reason that it cannot be done just as well as when the organization was smaller and there was more time to do it. In our personnel problem we were fortunate in being able to rely on the excellent training being given in our aviation schools. The calibre of the men they have turned out, and are continuing to turn out, is gratifyingly high. Even with such a fine backlog of material, the factor of selection is important, nevertheless.

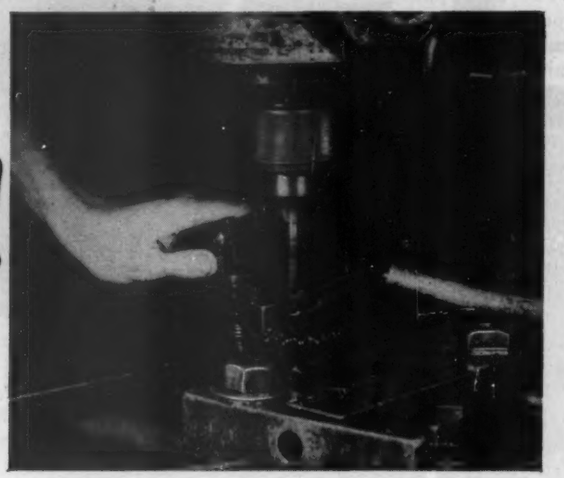
As regards training, this has been one of the most important items in Pan American's program of developing the "quick turn-around". Training cannot be overemphasized and in a program of this sort it is important to train and train, and train—and then when this has been accomplished, train them some more.

On the transatlantic service those men in charge of our training are, generally speaking, the most experienced men we have. Not all experts are good teachers but in our case we have been fortunate to have men who are senior in experience and able to train other men. Under this system, some of our most experienced men are therefore not doing productive work—productive in the sense that they are actually performing mechanical tasks themselves. However, the training program they are carrying out speaks for itself.

Along with the highly selective hiring and intensive training of personnel, an adequate staff of supervisors and inspectors was a third important item in the program. The nature of our business requires "check and double check" in every possible way and the importance of maintaining an adequate staff of men to perform this service cannot be overemphasized.

Power plants are worked on as complete units "in front of the fire wall". An engine change requires about 4 hours—about one hour to get the hoist up and take out the old engine, 2½ to put the new engine in, ½ to take the hoist down. Engines are 1800 hp. Wright Cyclones.

Make Your Taps LAST LONGER!



The right lubrication helps. It will give faster production, better size control and smoother threads, too. Here are a few tips.

***First*: Use plenty of lubricant. Put it where it will do the most good. Force it into the hole parallel with the axis of the tap if you can — use two streams on horizontal tapping. For deep tapping and finer pitches, use light or diluted oil to insure reaching the point of the tool. Be sure it's flowing when the tap starts to cut. This helps wash out the chips, too.**

***Second:* Keep the lubricant clean. When it becomes dirty or gritty, replace it with new, clean lubricant.**

***Third:* — and very important, different materials require different lubricants for most efficient tapping. Your oil company's lubrication engineer will give you specific advice, but here are some useful general hints.**

This is one of a series of advertisements published by Greenfield Tap and Die Corporation to help users get greater production from their small tools in these critical times, through making useful facts more widely known

SUGGESTED TAPPING LUBRICANTS

Material Being Tapped	*Lubricant*
Allegheny Metal	Sulphur Base Oil
Aluminum	Kerosene & Lard Oil
Bakelite	Dry
Brass	Compound or Light Base Oil
Bronze	Compound or Light Base Oil
Bronze—Manganese	Light Base Oil
Copper	Light Base Oil
Die Castings—Aluminum	Kerosene & Lard Oil
—Zinc	Compound
Duralumin	Compound or Kerosene & Lard Oil
Fiber	Dry
Iron—Cast	Dry or Compound
—Malleable	Compound or Sulphur Base Oil
Monel Metal	Sulphur Base Oil or Kerosene & Lard Oil
Nickel Silver	Sulphur Base Oil or Kerosene & Lard Oil
Rubber Hard	Dry
Steel Cast	Sulphur Base Oil
Steel Chromium	Sulphur Base Oil
Steel Machinery	Compound or Sulphur Base Oil or Kerosene & Paraffin
Steel Manganese	Compound or Sulphur Base Oil or Kerosene & Paraffin
Steel Molybdenum	Sulphur Base Oil
Steel Nickel	Sulphur Base Oil
Steel Stainless	Sulphur Base Oil
Steel Tool	Sulphur Base Oil or Kerosene & Lard Oil
Steel Tungsten	Sulphur Base Oil
Steel Vanadium	Sulphur Base Oil

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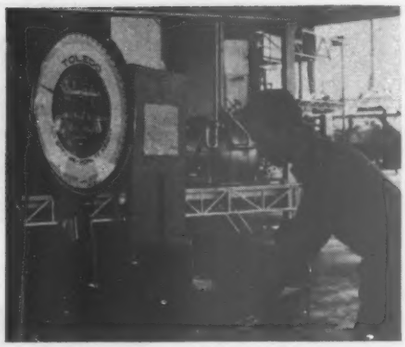
The development of every practical type of work equipment which would tend to eliminate the time-cost of a maintenance or inspection operation is another important item, followed throughout the entire Pan American Airways system. The company's interest in work equipment, particularly in completing elaborate workstands for the use of its maintenance crew, is as old as Pan American's use of large airplanes. As its airplanes grew larger and its experience longer, workstands have grown more and more elaborate. Today the big three-decked workstands that are wheeled beneath the wing of a B-314 within a few minutes after it has arrived in the hangar after an 8,000 mile round trip to Lisbon, are virtually complete work shops in themselves. The ones in use at LaGuardia Field, for instance, represent an investment of approximately $20,000 a pair. As the pressure for maintenance speed increased, these principal workstands have been supplemented by special inspection ladders which are used for working on the tail surfaces and other parts of the Clipper not reached by the main platforms. Hoisting apparatus, attached both to the hangar and to mobile units, is very complete. Several special dollies and trucks have been developed for special functions. Such elements as engine nacelles, wings, tail surfaces and hydrostabilizers, once detached from the plane, are handled in specially prepared jigs or service stands. Individual shops, such as metal working, engine overhaul and instrument and propeller laboratories have been furnished with every obtainable piece of usable equipment.

The creation and active use of spare and replacement parts is, naturally, a major item in the quick turnaround and is, of course, nothing new in the policy of saving turnaround time on a particular assignment by replacement of parts which need servicing with a new or preserviced element. At LaGuardia Field this policy has simply been carried further during the past two years than it ever had been carried previously. Originally applied to propellers, engines, accessories and instruments, it is now used in connection with practically all parts of the Clipper, such as elevators, ailerons, rudders, oil tanks, fuel and water tanks, and even hydrostabilizers (which cost some $20,000 apiece when purchased as spares). Even cabin upholstery, and furniture is frequently replaced and later serviced in comparative leisure in Pan American shops.



Every part must be weighed as it comes off and before it is put back on the Clipper.

Another spearhead in Pan American's "offensive against time" has consisted of the many measures to improve the organization and work efficiency of our man power. Of the total staff in the Pan American maintenance shops at La Guardia Field some 185 men will work directly on any Clipper undergoing the quick turnaround, the remainder of them being assigned to such general shops as Metal and Carpentry. The largest division in the overhaul department is Plane Service, with the Metal Working crew taking second place. In third place, ahead of Engine Service and the Instrument Department comes the Cleaning Crew. Almost without exception all such groups and service crews are organized on the permanent threeshift basis to permit continuous work throughout the 24-hours of the day and night when the Clipper is in port.

The quick turnaround actually starts immediately after the last passenger arriving at LaGuardia Field walks down the gangplank and the last piece of baggage, mail and express is unloaded. At that moment a group of maintenance inspectors board the Clipper to begin looking for special work that must be done. A group of instrument specialists also go aboard to gather up all removable parts of the ship's navigation equipment and a crew of mechanics lays down floor mats and covers all parts of the Clipper's cabin upholstery with material to protect them from soiling during the maintenance procedure. While this work is under way the Clipper is being towed from the dock to the ramp, brought up from the water on special cradles and immediately washed down to remove all traces of sea water and salt spray. Incidentally, time has been saved here, too, for the entire process of beaching this 42 ton aircraft and towing it to the hangar now requires only a little more than an hour, compared to an average of four or five hours necessary for the same process when we first started operations. Once within the hangar the huge workstands are moved into place, cleaning crews go aboard, service crews converge upon the parts assigned to their special attention and the process of quick turnaround is in full swing. Within six hours of the time the Clipper has settled on Bowery Bay every first inspection and every required work order has been completed and the work is well under way.

This process is speeded up materially by the fact that there are at least two Engineer Officers aboard every transoceanic Clipper. They keep constant watch over every part of the airplane and are able to gain access to the engines in flight by means of the engine stations behind each nacelle. Their minute observations and recordings, made available to the maintenance groups immediately upon the return of a Clipper, are partly responsible for the work orders flowing so quickly.

Within 48-hours the big Clipper should be ready once more to take to the air. Recently, to meet an extraordinary demand, the LaGuardia Field crew completed an entire turnaround process on a Clipper in only 17½ hours, a period only 12 percent of the time considered necessary a mere two years ago. No one in that crew would care to suggest any such interval as a normal assignment nor would they imply that bases elsewhere might be held to such a speedup. But no one in aviation today can say that tomorrow's problems may not make today's extraordinary achievements the commonplace of the future.

The accessory shop is as well equipped as an elaborate factory laboratory.

REPEAT for '42

STINSON GOES

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THERE'S no tougher test of engine performance than the long hard hours of cross-country pilot-training operation. In again choosing the rugged Franklin 90 H.P. to power Stinson Voyagers exclusively, Stinson engineers and the Army and Navy instructors who collaborate with them pay Franklin the highest compliment in their power.

Franklin will continue to prove its superiority by rewarding owners and operators of both private and training planes with smooth, economical, dependable power. Specify Franklin for the plane you fly or buy. Write us for specification sheets and performance data on the Franklin 90 with Electric Starter and Generator. Or see your Plane Distributor for details on the Franklin line . . . proven engines of 65, 75, 80, 90, 125 and 130 Horse Power.

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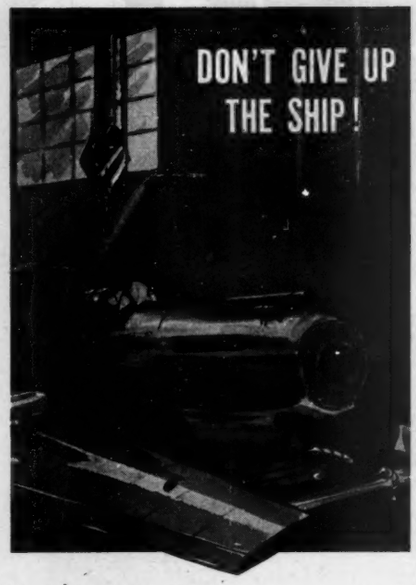

AMERICA'S aircraft plants are turning out ships for the defense of the Democracies. But it takes fifteen men to service, repair, and keep each ship in operation. Trained men are needed as never before to "KEEP 'EM FLYING." Unless we have these skilled specialists American Air Defense, the planes, and pilots will be helpless. Train now for the one assured industry of the future.

START IN AMERICA'S AIR GATEWAY

Embry-Riddle offers private students in technical, mechanical, craft and flight courses the same high standards which have made it one of America's greatest air training organizations—

Here, too, you'll enjoy South Florida's unequalled advantages of climate, healthful outdoor living and sports—the thrill of beginning your aviation career in the air gateway to Latin America, terminus of U. S. —Africa service, center of military, private and commercial aviation. Special Spanish & Portugese courses.

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Contractors to U. S. Army Air Corps---Royal Air Force---Civil Aeronautics Administration

British Study U. S. Aircraft

(Continued from page 70)

ward the immediate problem of providing thoroughly trained R.A.F. ground crews as quickly as possible to service and repair American flying equipment now in active service with the British air forces.

Quite apart from this, but having a similar purpose, is a program under which a number of sergeant-instructors of the R.A.F. are taking special courses on particular aircraft. However, this is part of a long term program looking toward the adequate dissemination of knowledge regarding American equipment in the regular training of R.A.F. service men. These men will return to Britain to serve as instructors in schools for instructors.

Both of these programs together represent the efforts of the British to meet their half of a larger problem which America must also help to solve. Elsewhere in this issue, are described the steps taken by United States plane manufacturers abroad to assist British Authorities in maintaining their products at the utmost peak of efficiency. (See Bell servicing abroad, Fornoff, page 60, and Lockheed servicing abroad, Stunkel, page 58.)

There are so many radical differences between the two countries' methods of construction, measurements, standards for threads, nuts and bolts and consequently, tools, that confusion and delays in servicing and repair are inescapable unless every practicable provision is made to anticipate and overcome the innumerable discrepancies beforehand.

Most American service men who have actually had considerable experience in England or other British possessions agree that the larger proportion of spares, tools of all kinds, disposable materials and items such as rubber tubing, glass, nut plates, springs and so on now included in the British orders are urgently required.

It is certainly not meant as a reflection on British skilled workmen, but actually they have far fewer tools of all descriptions to go around. American machinists and mechanics, with very few exceptions, own very elaborate chests of tools of their own, usually a couple hundred dollars worth. Nearly every American male, whether doctor, lawyer, merchant, mechanic or clerk, has around his household or automobile varying collections of screwdrivers, pliers, hammers, wrenches and files. This is not so universally true in any other nation.

If the matter is not already under consideration, it might be wise for our lease-lend officials and the British purchasing people to study the advisability of instituting a large-scale program for supplying the British with quantities of standard hand tools for wide distribution in servicing squadrons and repair depots. This is particularly important in view of the vast quantities of American machinery of all kinds which will be in use with their armed services in the near future.

Some of the common tools and similar items for which an acute need frequently is experienced in servicing American flying equipment abroad are:

Open-end, box, crescent, monkey and pipe wrenches, all sizes
Phillips and Reed & Prince screw drivers for recessed head screws, all sizes
assorted screwdrivers, all sizes
adjustable pliers and wire cutters
drift punches
reamers
ball-peen hammers
special tools for standard fasteners
grease guns
Prestone and hydraulic fluids

The greatest caution must be exercised on both sides of the Atlantic to avoid future shortages of these and thousands of other similar items. "For want of a nail a kingdom was lost." So runs an old saying. Likewise, for want of a grommet or washer a 25-ton bomber might be kept on the ground.

There are numerous procedural delays in the order and shipment of corrective or changed parts or replacements. Some manufacturers feel that British agencies can do much to shorten the time now required for urgent replacement orders to reach them. It is also felt in some quarters that our export control unnecessarily complicates service replacements. They feel that blanket licenses should be issued American firms to ship abroad technical data, parts, tools and replacements for planes already purchased. But whatever the difficulties, certainly the appropriate agencies of both nations should take all necessary steps to reduce to a minimum the time required for all needed spares, replacements, parts and tools to reach the spot where they will do the most good.

The question of tools and supplies for American flying equipment is all-important in connection with the scheme for training R.A.F. service teams here, for all their knowledge of our equipment will be largely nullified if they do not have tools and equipment to keep our planes in the air.

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READING AERO BATTERIES

. . . Designed especially for aircraft use, are meeting every requirement for starting, radio, instruments, etc.

Ten years of modern laboratory research, in close co-operation with both plane and engine technicians, has placed READING BATTERIES "FIRST" in aircraft acceptance.

READING'S two most recent developments—Types 324 L.D. and 333 L.D.—are especially designed and constructed for light plane use; packed with power; built of only the finest materials obtainable—yet carry not a single ounce of excess weight.

If Reading doesn't have it—Reading will build it.

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READING, PENNSYLVANIA • CABLE ADDRESS: "REBAT"

Northrop

(*Continued from page 83*)

iliary surfaces. Inherent stability has been obtained through development of the shape of the wing itself, and adequate maneuverability is provided by means of control surfaces incorporated directly in the wing.

Design of the Northrop type flying wing was initiated in 1923 and has progressed as opportunity afforded since that time. The pressure of designing and building conventional aircraft has prevented complete concentration on solution of the flying wing problem until recently. With formation of Northrop Aircraft, Inc., an accelerated program was initiated. It must be appreciated that many far-reaching factors are involved in the ultimate development of flying wing type planes. Not the least of these has been the perfection of "buried" engine installations with their problems of mounting, cooling, and driving through long shafts to remotely mounted propellers. Much work has been done along such lines by many people during recent years and all of this experience is applicable to the flying wing problem.

Also, the recent development of new airfoil sections of low drag and improved stability has had a profound influence on the further development of flying wing designs. Greatly increased experience in the field of spoilers, flaps, and various high lift devices has also helped materially in perfecting the flying wing plane.

Although the Northrop "All-wing" plane first flown in 1928 did make use of external control surfaces, carried on outrigger booms, it was quite radical for its time in the use made of high taper ratio, about 5 to 1, and high thickness ratio of the airfoil, about 33 percent. The fuselage was completely eliminated, the pilot being housed directly in the wing, the landing gear was retractable, and the engine was buried in the wing. In this early plane the extension shaft propeller drive was successfully demonstrated. Simplification of the airplane form to a simple wing and tail resulted in substantial elimination of parasite and interference drag. Efficiency of the high taper wing of thick airfoil section was also demonstrated. Concentration of the loads near the C.G. was proved advantageous both structurally and aerodynamically.

All of the experience gained through designing and testing this earlier Northrop flying wing, plus all of the knowledge available on this subject through trade literature, was incorporated in our development program on the new model. To this was added a very extensive wind tunnel program with model flying wing planes of a wide variety. At an early stage in the development the problems of design were discussed with Dr. Theodore von Karman, at that time Director of the Daniel Guggenheim School of Aeronautics at California Institute of Technology, and with his assistant, Dr. William R. Sears. Dr. von Karman is now employed by Northrop Aircraft as Aerodynamic Consultant, and Dr. Sears as Chief Aerodynamicist. W. J. Cerny, Assistant Chief of Design, has had the project under his direct supervision since its inception. The encouragement and assistance of these men, plus the enthusiastic collaboration of the Army Air Corps, has done much to accelerate development of the present successful all-wing plane. However, this project is in the nature of a flying mock-up.

We may, however, give a general description of the present plane, and some idea as to the effect it will have on airplane design. The original Northrop "all-wing" plane had a span of 30 ft. 6 in., length of 20 ft., height overall of 5 ft. Landing gear was of tricycle type with the main wheels forward and with a tread of 9 ft. Power was supplied by a single 90 h.p. Menasco.

In our present flying wing the figures are all given as approximate but will serve as a basis for comparison. Span is 38 ft., length 17 ft.

Landing gear is of tricycle type with the main wheels at the rear and a tread of 9 ft. Power for first test flights was provided by two 4-cylinder 65 h.p. Lycoming engines but these were later replaced by two 120 h.p. 6-cylinder Franklin engines.

Tests conducted to date have confirmed our engineering calculations. We expect a minimum improvement in all-around performance of about 25 percent as compared with conventional designs. And we believe that planes of this type can be built for as little as 60 to 70 percent of the cost of conventional planes of equivalent capacity.

Future of Flying Wing

It is probable that variations of the pure all-wing design will be developed with various bumps or excrescences incorporated to accommodate special loads, passenger cabins, gun turrets, etc. Such developments offer a wide range of possibilities without materially altering the basic characteristics of the plane. Also, various airfoils and airfoil thickness ratios may be used as design requirements dictate. An airplane of relatively slow speed can make use of thicker airfoils than a plane of higher speed and this factor indicates appreciable variations in the design. Limiting feature in application of various airfoils will be the compressibility factor. This is less of a handicap than with conventional planes due to the repression of all protuberances which normally contribute to local distortions of airflow to induce compressibility burbling.

Elimination of the fuselage and tail surfaces, and use of a very thick airfoil of high taper ratio greatly simplifies structural design. Not only is the structural arrangement efficient, resulting in savings of both cost and weight, but the added roominess makes it easier to install powerplants, accessories, plumbing, wiring, etc. Maintenance of the plane and its accessories is made easier and cheaper for the same reason.

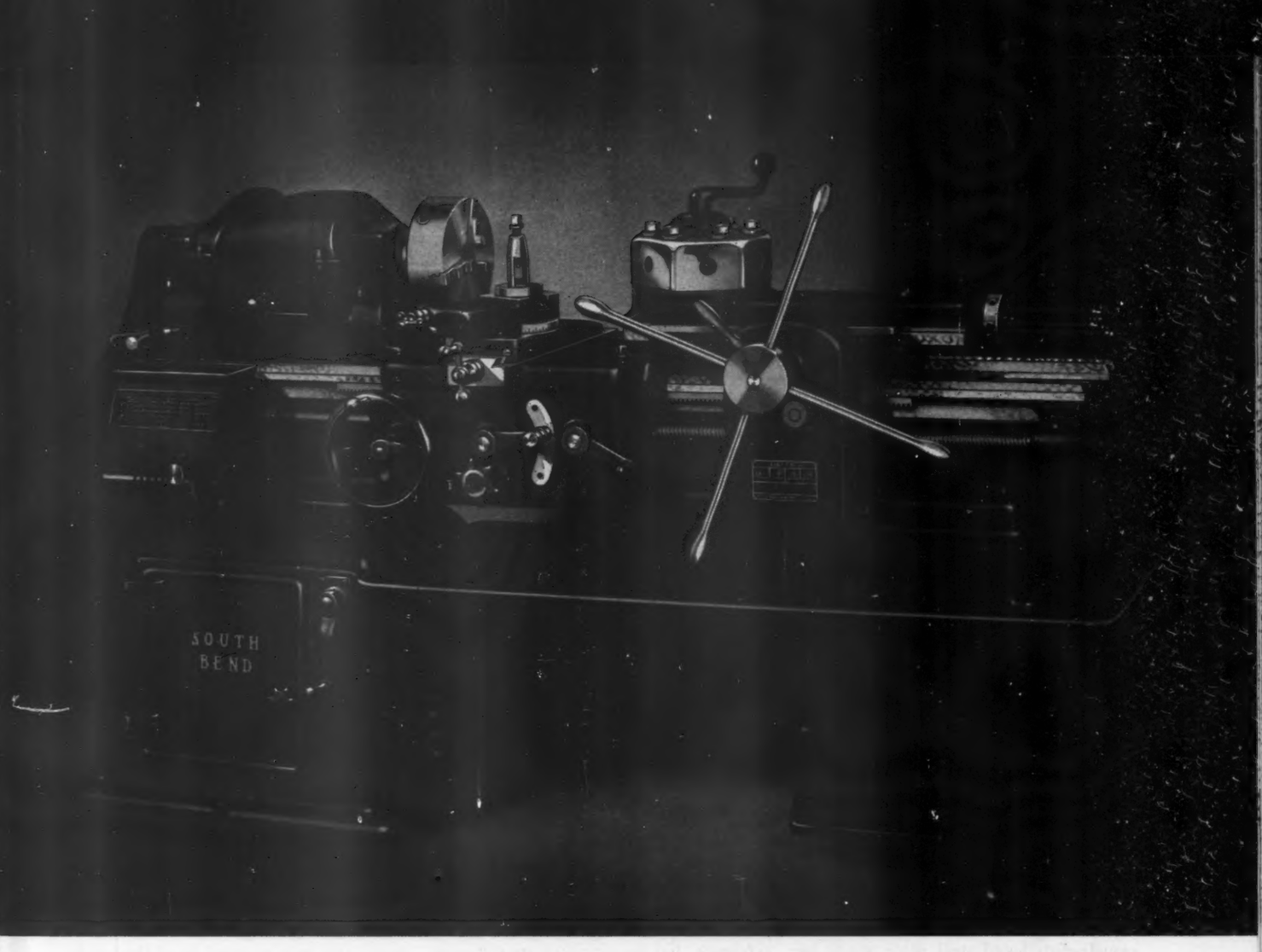
Vision for the pilot from a plane of this type is quite good. Even on the small flying mock-up he has good vision forward and downward over the nose. Due to the marked sweepback of the leading edge and the sharp downward slope of the upper wing surface it is only necessary to elevate the pilot sufficiently to place his eyes a few inches above the wing surface to provide excellent vision. Of course his view is completely unobstructed in all directions in the upper hemisphere. On larger planes of this type the pilot's cockpit may be moved relatively farther forward if desired. As for the passengers in a plane of transport type, an arrangement can probably be worked out to give them direct forward vision, a feature now lacking in our conventional transports. Downward and sideward vision should also be good if the cabin is bulged down a little from the under wing surface, and provided with sloping side windows.

Stability of the "all-wing" type plane is a feature which cannot be discussed in detail at this time. However, it can be said that hundreds of flights have demonstrated the present design to be entirely normal as to both stability and control about all three axes. The peculiar conformation of the wing, with pronounced droop of the wing tips, is based on both engineering analysis and extensive wind-tunnel and full scale testing. Test flights have been made with the wing tips in all possible positions. The present arrangement has been demonstrated to be entirely satisfactory. Relation of wing dihedral, wing tip cathedral angle, and other features of stability and control are subject to variation with specific designs.

Control is achieved through use of a system of "elevons" and wing-tip rudders. The "elevons" serve, as in other tail-less type planes, both as elevators and ailerons. Rudder action is provided by control surfaces incorporated in the drooping wing tips.

Application of high lift devices to

(*Turn to page 202*)



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THIS NEW South Bend 16″ Turret Lathe combines the precision and versatility of a toolroom lathe with the rapid production facilities of a turret lathe.

The power feed ram-type turret has six faces, with automatic indexing and individual stop for each face. The turret is mounted on the inside bed ways and may be clamped at any location the entire length of the bed.

The carriage has friction clutch drive for power cross feeds and power longitudinal feeds, also lead screw and split nut for cutting accurate screw threads. Mounted on the outer bed ways, the saddle wings clear the turret base to allow free movement of the carriage. Telescopic taper attachment, hand lever collet chuck and other attachments can be supplied.

The quick change gear box provides 48 changes for all carriage feeds and turret feeds. In addition, there is provision for changing the direction and speed of the turret feeds with relation to the carriage feeds.

The direct motor drive provides twelve spindle speeds ranging from 21 to 731 R. P. M. Headstock spindle has 1⅜″ capacity for bar stock. Rapid acting hand lever collet takes up to 1″ round stock.

In addition to this turret lathe we manufacture a complete line of back-geared screw cutting lathes, 9″ to 16″ swing, for toolroom and general shop use. Also 9″ and 10″ swing lathes with hand lever bed turret. Write for our catalog on this new lathe and the name of our nearest dealer.

TRADE MARK SOUTH BEND TWINS ENGINE LATHES

SOUTH BEND LATHE WORKS

Lathe Builders For 35 Years

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Edward Warner

(*Continued from page 49*)

the assault upon the enormous technical problems that it presents been so continuous, and engaged such an amount and quality of engineering and inventive talent, as to realize practical serviceability. The auxiliary supercharger, driven by an exhaust turbine, is already making it possible to conduct bombing expeditions at altitudes well above any that were previously attainable. It may rank with the development of heavy bombers among major American contributions to the aeronautical technology of this war.

In addition to the differences in development policy and in specialized national interest, there have been the differences between a nation at peace and one already at war. In time of peace, the military aircraft is commonly judged primarily as a flying-machine, and only secondarily as a fighting craft. In time of peace, the fitting of armor seemed an outrage against aeronautical science; but after the fall of 1939 it took only a few weeks of accumulating experience of the men who were actually being shot at in the air to convince designers that the weight of a little judiciously-distributed steel plate would be weight well expended, even though it increased the landing speed of the airplane by three miles an hour, or lengthened the take-off run by 100 ft.

There was, for example, the case of the leak-proof fuel tank. In 1919, with recent unhappy memories of aircraft coming down in flames, it was a general assumption that protection of the tank against ready loss or ignition of its contents by enemy fire was essential. Reasonably efficient means of leak-proofing the tanks were developed; but leak-proofing was heavy, and bulky, and sometimes shortlived. It gradually disappeared from the art, only to return when another war began to furnish tragic reminders that bullets still punctured unprotected tanks and drained the fuel away, sometimes with fire resulting.

To the problems of design and construction must be added those of getting the aircraft into service. At least three-quarters of such troubles as have been experienced with American aircraft in the British Service,—and there have been some troubles,—have been due to nothing inherent in the aircraft themselves, but have arisen out of the problem of fitting different types of equipment together, and of providing all of the information and all of the auxiliary supplies that were necessary for efficient use. Fortunately one may now speak of these difficulties primarily in a historical sense, for most of the troubles that were apparent six months ago have now either been entirely overcome or are well on the way to disappearance.

To realize the troubles that may be experienced in moving even the best of equipment from one environment to another, it must be remembered that a military airplane does not operate as an independent unit, but as a working part meshed into a vast and intricate system. Where British and American designs for auxiliary equipment differ, there must be a change of practice somewhere in order that the airplane and its consumable supplies may operate together. Bombs have to fit bomb-racks; ammunition has to fit guns; and guns to fit mounts. Changes in gun installation may involve a change in firing control running all the way to the pilot's cockpit. Radio sets must go into the space provided for them in the aircraft; but they must also have the frequencies and the other characteristics to enable them to work within the framework of the communications system established in the country where the aircraft is to be operated, the alternative being to make extensive revisions in the ground equipment.

Even the most trivial details can be annoying. Both British and American Services, for example, have a standard practice in the folding of maps for ready reference; but the practices are different enough to make it difficult to keep the standard maps of one country conveniently available in a map-case designed to hold those of the other. Other points have been far more important. There was a case, for example, in which the necessary changes in radio and other electrical equipment required a change in the characteristics of the generator driven by the engine. That in turn modified the engine's vibration characteristics, and it was only after a period of very urgent shop and laboratory work that means of overcoming the resultant mechanical difficulties were found and introduced.

Some differences require a period of familiarization for the pilot before he can feel at home with the new equipment. It appears to be true, for no particular reason, that the natural position of the control stick in level flight in most British aircraft is farther back towards the pilot's body than in similar American machines. A pilot accustomed to flying with his arm in a certain position finds any other position uncomfortable until he gets used to it. A more important matter is the habitual use of quite different types of brake control in the two countries; and there are others.

Aircraft can be moved from place to place at very high speed, but their lives in useful service may be short when they arrive unless a considerable supply of spare parts has kept pace with them. Not only is a stock of spare hardware needed, and tires, and engine and propeller parts and instruments and the like, but also special tools, and working-benches, and jigs for re-aligning wings and bodies after they have been damaged and distorted, and other special fixtures. Shortage of spares is often a grave handicap for aircraft that are operating within a few hundred miles of the factory where they were built. The handicap is vastly greater, and a proper organization is proportionately more difficult to work out, when the needs must be communicated in coded cables, and the needed material dispatched across an ocean. Even in the relatively simple and unmechanized days of our grandparents, there was current a sort of house-that-Jack-built jingle that worked up to a grand climax of how the battle was lost for the want of a horseshoe nail. Battles in the air may be lost for the want of lubricating oil of the precise specification on which the engines were designed to run; for the want of an adequate supply of exactly the right type of spark plugs; or for the want of the coils which will convert a radio set to enable it to operate on the proper frequencies.

Another difficulty often arising has been that of getting adequate instruction books and such material to all the places where they will be needed. The airplane often outruns or becomes separated from the information that ought always to be in the hands of those charged with operating and maintaining it. I dwell upon such seemingly small matters because, small as they seem, they are capable of making a vast amount of trouble, and have on occasion actually done so; and because of the satisfaction with which I can express my confidence that the problems of supply of material and of information, and of modification where necessary to fit a change in environment, and of accustoming personnel to the unfamiliar characteristics of the trans-Atlantic equipment, are all progressing towards more and more complete solutions.

Such problems are inherently those of the early stages of association. Arrangements for each new type of aircraft to be preceded by an account of its special qualities and operating demands, prepared from the point of view of the pilot, now insure that the first examples of the type to arrive will not be received as unproved strangers, but with the confidence that goes to the bearers of impeccable credentials.

The role of the service representatives of the American industry is of enormous importance in this work of familiarization, as well as in dealing with those mechanical troubles to which all highly-

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stressed machinery is occasionally subject. There has been a growing appreciation that delicate and complex mechanical equipment, for its most efficient operation, needs occasional attention and operating counsel from engineers and mechanics who have known that equipment from its inception. The resultant attempt to keep the number of service representatives in England of the American industry commensurate with the rapidly growing amount of American equipment there is a recognition of one of the fundamental requirements of getting the most out of the aircraft and their engines and accessories. The guidance that American-trained experts can give is particularly important under the conditions of a country at war, with skilled labor never available in quantities to meet all the demands, and with every resource of manpower and womanpower, and every expedient for speedier training for mechanical jobs, necessarily pressed to the limit.

I have been dwelling particularly on military air material, but civil aviation is also of national importance, even in time of war. It has the importance that always attaches to the swiftest possible transportation of persons, goods, and communications in times of special emergency; but it also has the significance of an instrument of national policy in international relations, and of a vital instrument of military communications. For embattled Britain, air transport supplies communication and conveyance between areas of which the connection by surface means of transport is so slow and roundabout as to be virtually nonexistent. The pressure is so great that the would-be traveler by a British transport plane finds it necessary in many cases, and wise in almost all, to support his application with a government-issued certificate of priority. We have reached no such stringency as that, though we have approached it on the trans-Atlantic service; but we too are deeply dependent upon air transport in this crisis, at home, across both oceans, and for swift travel and exchange communications within the western hemisphere.

There has been an impressive manifestation of hemispheric unity in the steps that the American Republics have taken to uproot the ominously penetrating German-controlled lines.

It becomes increasingly important that the air transport systems within the United States, and those connecting us with neighboring countries and extending overseas, should operate during the emergency with a sole concern for the swiftest possible adaptation to national requirements, in the order of their urgency, and for the rendering of the greatest possible aggregate of service with the greatest economy of men and material. They operate under a legal framework drawn in terms of peace conditions. It provides for development primarily through the initiative of the individual airlines, with the agencies of Government giving their applications judicial consideration in accordance with an established judicial procedure, rather than for Government initiative and sponsorship of the establishment of services where the national interest requires them; but air transport, especially in the international field, has now to meet the test that is to become the universal touchstone of all our pursuits and professions. It has to be the expression of a national purpose that gives an unquestioned priority to the needs of the present emergency, and very little weight indeed to any considerations that do not coincide with the emergency's requirements. Considerations of competitive positions either for the present time or for the period after the war recede into comparative insignificance. Its success in the years immediately ahead will not be judged by ordinary standards, but by the accuracy with which it conforms to the emergency's demands and finds solutions for the emergency's abnormal problems.

Bell Abroad

(*Continued from page* 61)

afterthought to sales. The Bell Aircraft organization has pioneered in this respect by divorcing the sales and service departments and giving them coequal status.

Service, with related problems of maintenance, is integrated with all the productive processes from design to operation of the finished product. When the ideal design for a part or mechanism is produced, not only are production planning and operational engineers called in to study it from the standpoint of practicability of fabrication and assembly, but the service engineer as well, to pass on it from the standpoint of simplifying and minimizing servicing.

Likewise, if experience demonstrates an inherent disadvantage of a particular part or accessory, or its location, from a maintenance point of view, service men consult with the design engineers to determine if some modification cannot be made which will simplify maintenance or speed up servicing.

Always, one guiding principle dominates the thinking of Bell Aircraft engineers. No matter how fine their airplane, it is still worth less than the poorest aircraft so long as it has to remain on the ground. It can only be a *good* airplane while it is in the air or all set for the takeoff.

Since the time element is so important, particularly in the servicing of military aircraft, structural features and location of accessories and equipment rank with performance and efficiency of operation in the overall effectiveness of an airplane. A particular feature of the Airacobra's design which has proven its value in this respect is the method of wing attachment to the fuselage.

A single set of jacks is all that is necessary for erection or disassembly, eliminating the need for an overhead hoist of any kind. If a wing or landing gear must be replaced or repaired, no crane is needed. Only in removing or installing the engine is such a rig required. This greatly facilitates repair and replacement in the field.

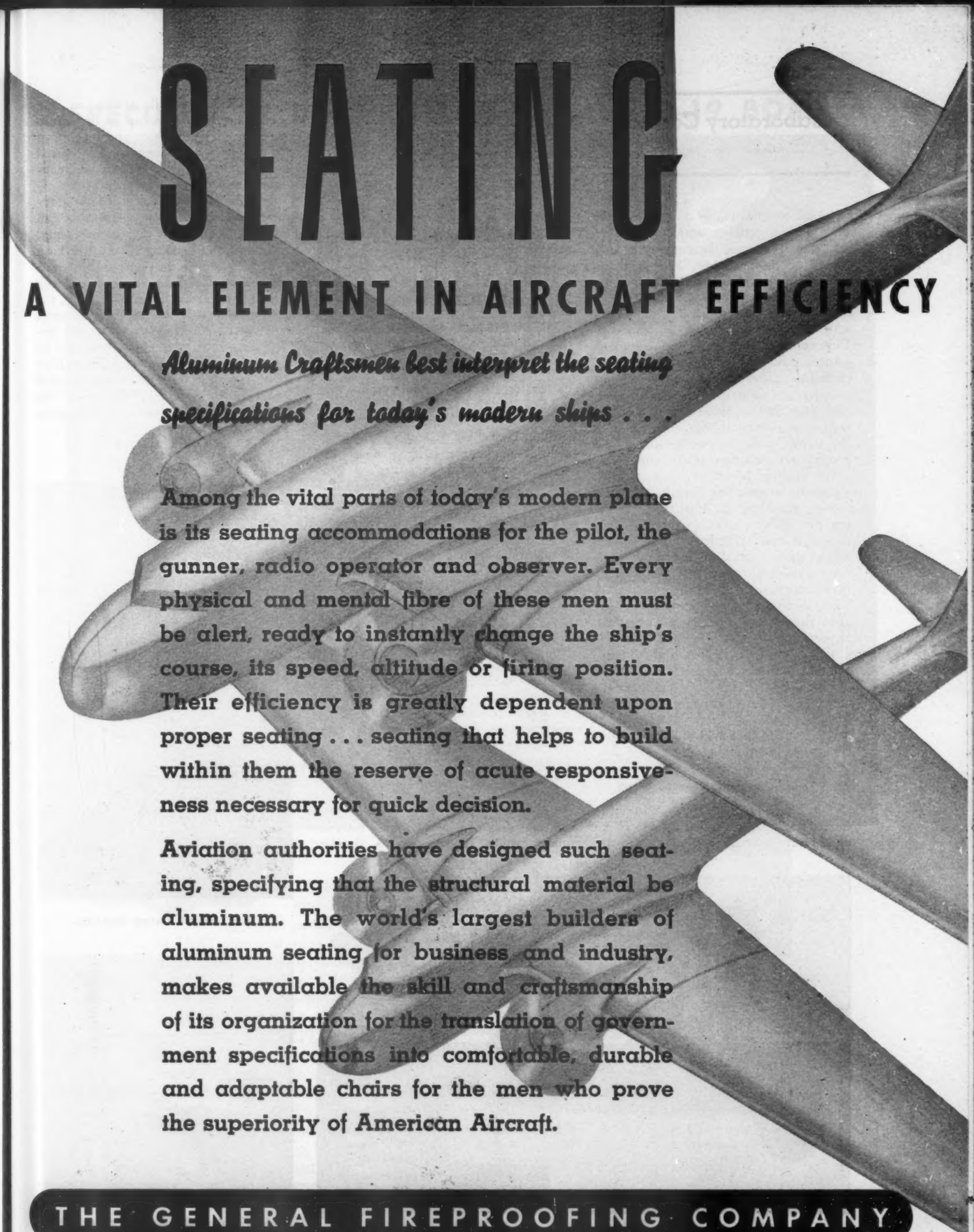
Use of the tricycle landing gear has also been an aid to servicing, because the fuselage and wings remain in level position when the craft is on the ground. The fact that the airplane, itself, provides a level platform on which service men may work perhaps seems unimportant, but it is of great value, particularly in the field, where special work platforms are not available.

The great number of inspection plates, as well as the cowling plates, attached only by Dzus Fasteners, also aids during the servicing of the Airacobra. Availability of power plant control and fuel lines and accessory equipment is of paramount importance to a crew charged with keeping aircraft in operational shape, during wartime conditions especially.

The inescapable conclusion to be drawn from our experience is this: the responsibility of the plane manufacturer should not be regarded as ended when the planes and spares are delivered according to contracts. If the effectiveness of his product is to be fully realized, the far sighted manufacturer will voluntarily see to it that his product gets every chance to perform properly.

To see the wisdom of this course, we need only reverse the circumstances of the two nations. If we were waging a war and obtained British planes of quality and usefulness we would naturally try to utilize them. However, if for the lack of replacement parts, proper tools at the proper place, or trained mechanics to spare who could perform the work, we had to push them aside and do our utmost with familiar equipment, we would not be all to blame.

But—suppose there were an Englishman at hand or on call, ready and qualified to help us use it and tactfully showing us how to get the most out of it. You may be sure there would be small likelihood of it deteriorating in a shed or under a tree some place for lack of a cotter pin or a wiring diagram.



SEATING

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Among the vital parts of today's modern plane is its seating accommodations for the pilot, the gunner, radio operator and observer. Every physical and mental fibre of these men must be alert, ready to instantly change the ship's course, its speed, altitude or firing position. Their efficiency is greatly dependent upon proper seating . . . seating that helps to build within them the reserve of acute responsiveness necessary for quick decision.

Aviation authorities have designed such seating, specifying that the structural material be aluminum. The world's largest builders of aluminum seating for business and industry, makes available the skill and craftsmanship of its organization for the translation of government specifications into comfortable, durable and adaptable chairs for the men who prove the superiority of American Aircraft.

THE GENERAL FIREPROOFING COMPANY

YOUNGSTOWN · OHIO

Laboratory Control

(*Continued from page 109*)

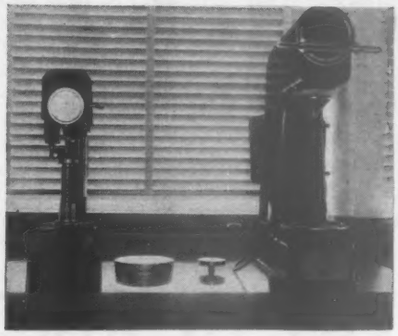
chemical treatments. This ensures their smooth, high quality and trouble free operation. Bronze bearings are analyzed for their copper, lead, and tin content. Oil sludge is tested to indicate the amount of piston wear. One device of particular interest used in the chemical laboratory is the electrophotometer. This employs an electric eye to look at colored solutions. By this means rapid chemical analyses are possible. New products are examined to find out their suitability and application to the manufacture of engines. Routine analyses of the alloys used in the details of the product are also part of the work done.

An etching laboratory uses various chemicals to treat the surface of metals thereby revealing the flowlines or bringing out defects such as cracks. Corrosion testing is done using a special temperature controlled salt-spray tank. This produces conditions which cause rapid corrosion in many materials. Various paints and treatments to prevent rusting may be tested with this apparatus.

With a heat-treating laboratory much can be learned about the hardenability of various metals. Two automatically controlled electric furnaces are utilized for this type of work. Research is carried out in this field and its application to production investigated.

Photoelastic Method Proves Worth

The photoelastic analysis being conducted at Ranger represents one of the most recent practical applications of this method to airplane engine manufacture. Models of parts to be analyzed for stress are fashioned of transparent plastic, such as Bakelite. Circularly polarized light when transmitted through the model and focused on a ground glass screen presents a contour map of colored lines which reveal the principal stress differences.



Rockwell and Reflex Vickers hardness testing machines in physical laboratory.

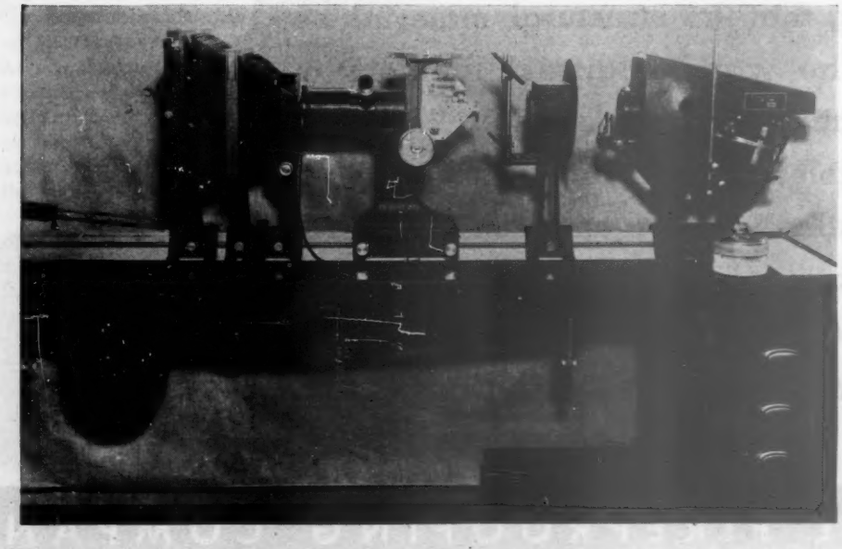
An engine part which failed in service revealed no flaws in material or workmanship when analyzed by the usual methods. It was then sent to the photoelastic laboratory. An exact model was made. Stress patterns were observed and photographed revealing that the part broke where the tensile stress was 55 percent higher than at any other point. As a result the part was redesigned so as to remove this 55 percent of stress concentration—virtual insurance against any future failures from the same cause.

The Magnaflux Company's Stresscoat system is used in strain analysis. Parts or models to be studied are evenly coated with special lacquers. After this coating has hardened, the material under study is stressed to simulate actual loads. Small cracks in the lacquer begin to show up as the strain increases. The direction and spacing of the cracks disclose to the experienced operator much useful information concerning the part under scrutiny.

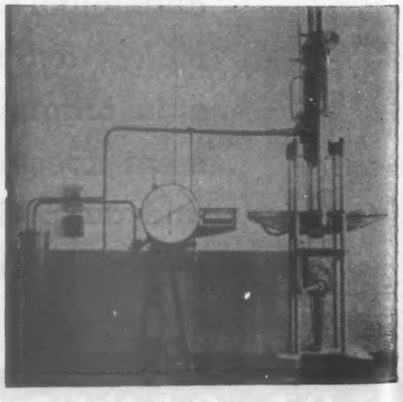
In the physical testing laboratory things are learned about metals that can only be found out by compressing, stretching and bending to the breaking point. A tensile testing machine can exert a compression or tension force from 100 to 60,000 lb., and produces the stress-strain diagram for the material under test. An Izod impact testing device determines just how resistant to impact are certain steels. Four high speed fatigue-testing machines, revolving at 10,000 r.p.m., determine the fatigue limits of various materials under different loadings.

(*Turn to page 192*)

Izod impact testing machine.



Micro laboratory metallurgical microscope.



Tensile testing machine with capacity from 100 to 60,000 lb.

SPECIFIED BY DOUGLAS FOR THE B-19 BOMBER

Kronquist Photo

Not the bones of a pre-historic monster but the various parts of a Ryan Universal Joint Manifold for the B-19

Ryan

TO PRODUCE exhaust manifolds that will hold the fire of 8,000 horse power on sustained military missions of 7,000 miles and more was just part of the assignment filled by Ryan in supplying collector rings for the Douglas B-19, "Guardian of a Hemisphere." Other engineering requirements dictated Universal Joint Manifolds, developed by Ryan over three years ago, and on which U.S. Patent No. 2,219,752 has been issued. Ryan feels honored in having been selected to develop the world's largest exhaust manifolds for the world's largest bomber. ¶ Your exhaust collector ring needs may not call for so huge an installation as on the B-19, still the problems involved may be even more intricate. If so, you too can benefit by Ryan engineering experience and production facilities. Ryan produces *all* types of exhaust manifolds to meet *any* requirement. We are producing at three times the volume of a year ago, and making deliveries in advance of customer's needs. Yet, recently expanded facilities assure capacity for a large additional volume of exhaust manifold business. Your and our engineers should get together.

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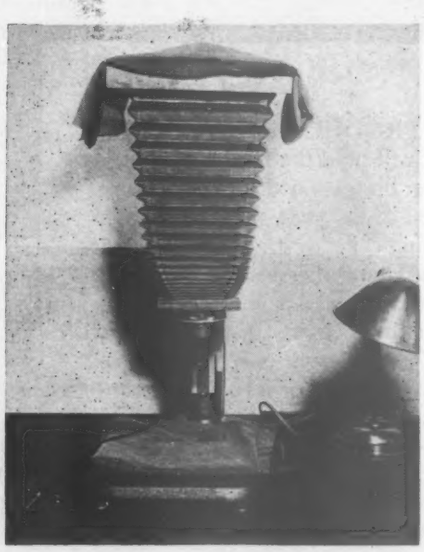
(Continued from page 190)

Two hardness testing machines, a Rockwell and a Vickers Reflex Tester, complete the equipment of the physical laboratory. The Reflex tester is possibly the only one of its kind in the United States and is particularly interesting because of its ability to measure the relative hardness of metals without leaving a serious flaw on the surface of the piece tested. A finely-ground diamond point is pressed against the metal. The resultant depression, hardly visible to the naked eye, is magnified powerfully and projected on a ground glass screen. The image cast on the screen is measured and from this measurement the true surface hardness of the metal can be determined with a high degree of accuracy.

X-ray Lab. to be Added

A description of the microscopic equipment completes the listing of the major installations in the laboratory. However, the laboratories are now being enlarged and part of the added space will be utilized for a new X-ray laboratory. This X-ray apparatus will enable the observer to see inside the various parts and find flaws which yield to no other method. Important information on strains and grain structure may also be gained using X-ray diffraction equipment.

Microscopic examination is particularly useful in studying the structure or "grain" of metals. By this means it is frequently possible to ascertain whether a failure or flaw was the result of a fault in the metal itself or due to external forces. A sample of the metal to be studied is first molded in Bakelite, then polished until it offers a plane surface, mirror smooth. It is placed before a powerful microscope, which can give any desired magnification up to 2000 diameters visually or photographically. Other equipment comprises a binocular microscope and a macrocamera. Another complete metallurgical microscope is on order.



The macro camera in the Ranger metallurgical laboratories is used to photograph flaws and fractures in bearings or other small parts at many times larger than life size.

The major purpose of the laboratories is absolute control of materials going into the fabrication of the engine. An equally important function is the study and investigation of all experimental and service failures to determine their cause and cure. But it is fully obvious that this persistent investigation and questing for better materials and methods of manufacture inevitably leads to developmental research—a by-product which pays big dividends when harnessed as it is at Ranger.

The by-products of research and experimental development can—and frequently do—determine the survival of those commercial organizations faced with the challenge of diminished and dislocated markets. In the admittedly difficult period which will follow close on the heels of the war's end, flexibility of method and elasticity of thought, coupled with a dynamic will to anticipate, even *create* new social wants and develop artificially retarded markets, will enable aviation producers, with few exceptions, to continue useful and productive activities within the structure of the national economy.

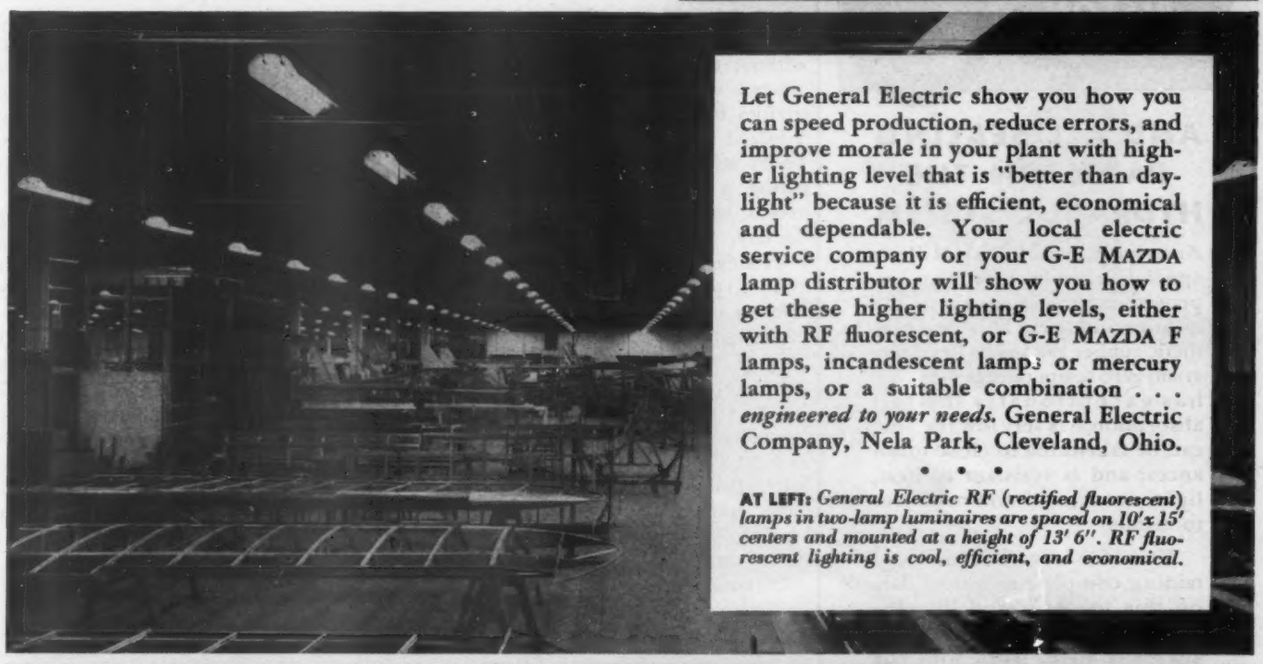
Much will depend, however, on the extent of collective and cooperative effort on the part of the whole industry. While Ranger is by no means the only aviation concern utilizing the laboratory extensively, the account of its equipment and some of its accomplishments should give rise to serious speculation on the part of many aeronautical producers whose plants are not similarly equipped.

In the era of free markets regulated by supply and demand unmodified except by acts of God, management's thinking could terminate with the delivery of its product and collection of the stipulated fee therefor. No longer can responsible businesses operate in this fashion. Successful and enduring commercial concerns must integrate their organization and products with the social and economic environment, plan years ahead, anticipate every possible eventuality and be ready with a carefully thought out program for each and every transition or dislocation which conceivably might eventuate. In a highly technical and mechanized industry such as aviation, the laboratory is the logical nucleus around which wise planning for the future revolves.

SEE HOW CLEARLY GENERAL ELECTRIC RF FLUORESCENT LIGHTING HELPS YOU READ THIS SCALE . . .

AT the Stinson Aircraft Company's Wayne, Mich., plant, General Electric's RF (rectified fluorescent) lamps provide 30 footcandles of "indoor daylight" to speed defense work. In this unretouched photo of the cross-feed dial on a typical lathe, note how clearly RF lighting reveals the markings, making them easy to read quickly and accurately.

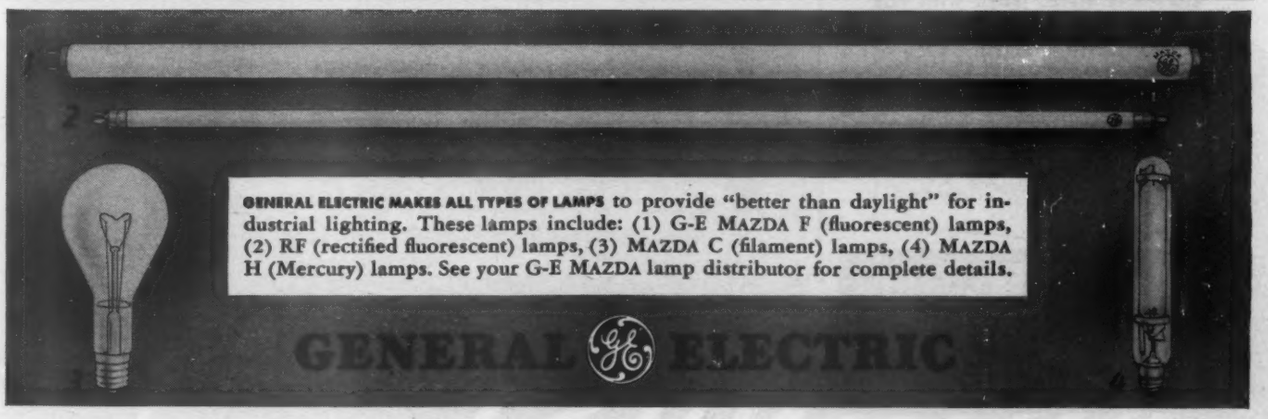
The illustration below shows how this lighting produces little shadow and brings out every detail of the plane, including fuselage and wing construction.



Let General Electric show you how you can speed production, reduce errors, and improve morale in your plant with higher lighting level that is "better than daylight" because it is efficient, economical and dependable. Your local electric service company or your G-E MAZDA lamp distributor will show you how to get these higher lighting levels, either with RF fluorescent, or G-E MAZDA F lamps, incandescent lamps or mercury lamps, or a suitable combination . . . *engineered to your needs.* General Electric Company, Nela Park, Cleveland, Ohio.

• • •

AT LEFT: *General Electric RF (rectified fluorescent) lamps in two-lamp luminaires are spaced on 10′ x 15′ centers and mounted at a height of 13′ 6″. RF fluorescent lighting is cool, efficient, and economical.*



GENERAL ELECTRIC MAKES ALL TYPES OF LAMPS to provide "better than daylight" for industrial lighting. These lamps include: (1) G-E MAZDA F (fluorescent) lamps, (2) RF (rectified fluorescent) lamps, (3) MAZDA C (filament) lamps, (4) MAZDA H (Mercury) lamps. See your G-E MAZDA lamp distributor for complete details.

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SPECIFY
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AND ALL SEALING PARTS ON THE HYDRAULIC SYSTEM

Ameripol*, adapted by Miller's special formula, offers an improved sealing medium to the aviation industry. This new synthetic rubber retains its flexibility at sub-zero temperatures (–50°F.); has exceptionally low oil absorption; has very low friction; can be fabricated to close tolerances; and is resistant to heat, light, ozone, and non-corrosive to metals.

Write for new bulletin containing complete technical data on this modern synthetic. Experienced Miller engineers are always ready to work with you in designing longer-lived, more dependable sealing parts of Ameripol*.

**Registered Trade Mark of The B. F. Goodrich Company*

IMPORTANT!
AMERIPOL* for defense production is available for immediate delivery.

MILLER RUBBER CO., INC.
AKRON, OHIO
(A Division of The B. F. Goodrich Company)
"Engineers in Rubber"

Servicing Canadian Kinners

(Continued from page 75)

blanketing or partial cowling of the barrels produced similar results. Warm air in front with cold air in the rear caused heavy condensation throughout the rear section, and this added further complications, such as rust in the timing gears, valve tappets, accessory drives, etc. Icing occurred in the induction system. Water froze on the oil screens, stopping the flow of oil.

A conventional cowl with louvers cut in the rear section to permit a flow of air around the entire engine is now standard equipment.

In a like way Canada has worked out a number of practices with respect to cold weather operation and servicing which have materially contributed to the ultimate efficiency.

The vital importance of proper warm-up was not fully recognized at first. Airplanes were left out in below-zero weather during the lunch hour and then taken into the air immediately without warm-up. The danger of this practice was realized when some of the engines froze up for lack of oil causing a forced landing shortly after take off. Today at all Canadian schools the lunch period is staggered so that an engine, once it has been placed in operation for the day, is never allowed to grow cold.

Canada has found that the oil system in an airplane engine is its most vulnerable spot in winter operations. Even where planes are wheeled from warm hangars and allowed to stand for only a few minutes the oil will congeal. Different viscosities of oil were experimented with to lessen this danger. Oils as light as SAE 15 were used, but it was found that with light oil the film broke down under the pressure, while too heavy oils were quick to congeal. In each instance the net effect was the same—the bearings got no oil.

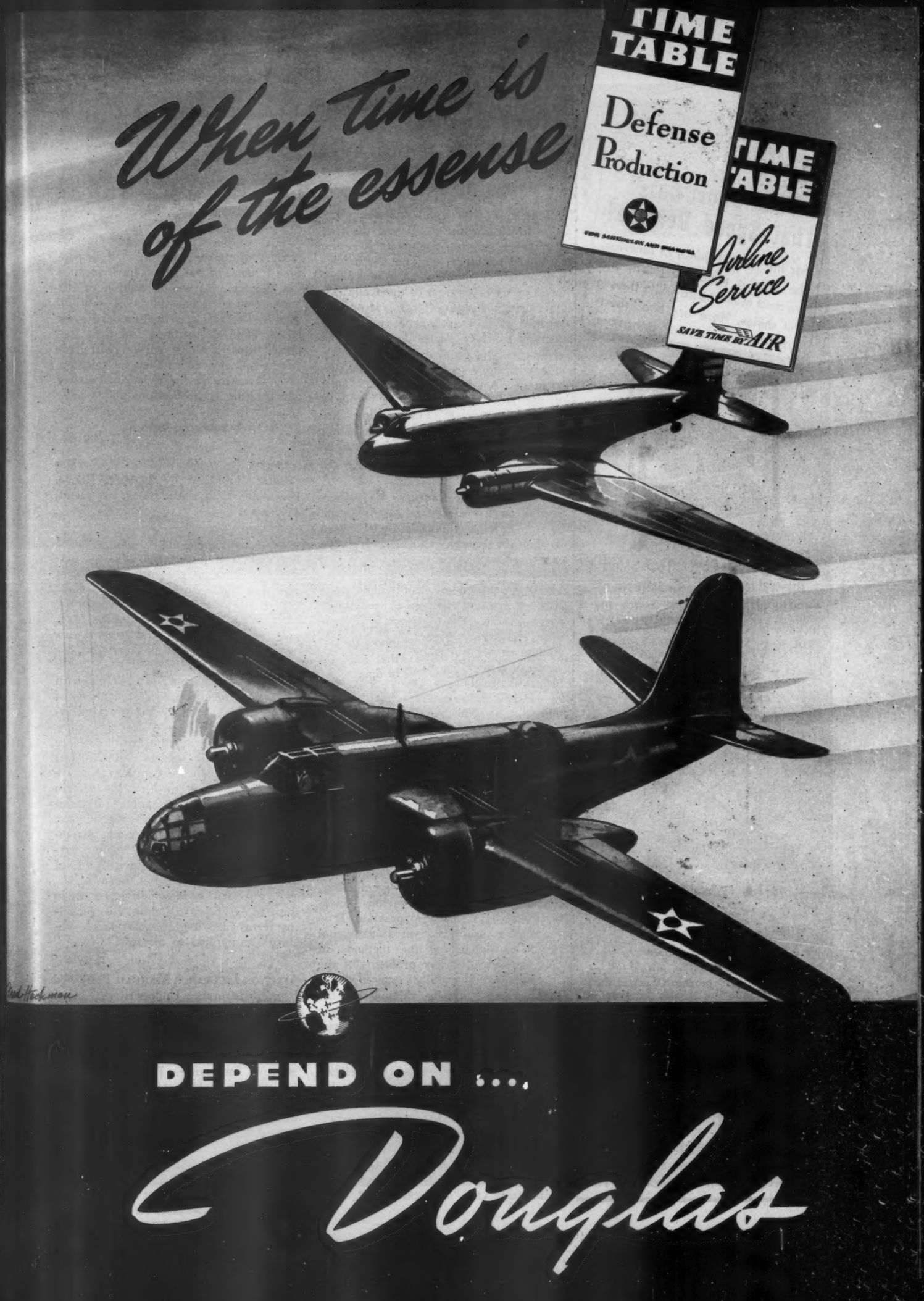
A correspondingly wide range of experiments were carried on with respect to oil changes. Out of all this had come an eminently satisfactory standardization. SAE 40 oil is specified and oil is changed at 30-hour intervals. In addition, engines must be started immediately after planes are wheeled out of the hangars.

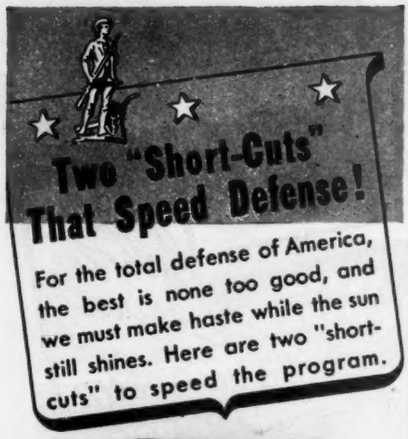
In the ultimate, Canada's experience sums up largely to this: once an engine has been warmed up so that the oil is circulating properly, the coldest weather makes little difference in its operation, but on the ground an airplane in Canada in winter demands entirely different attention than it does in California or Florida.

The application of this principle has produced far-reaching results. Engines operate under every conceivable condition—the sleet, snow and rain of winter, the dust and heat of summer—in meeting the gruelling demands of primary training. Yet, with weather's destructive influences surmounted and largely eliminated, they deliver a third more hours between overhauls and require far less servicing.

The Canadians may have done things the hard way. They might have had an easier time if they had established training schools in the milder regions of the United States. But you will find few of them who won't contend that the hard way was the best after all. The training continued in temperatures as low as 20 below and in two and a half months they flew 13,000 hours. The men who trained under these conditions were more than prepared for duties in Europe. They became veterans in flying conditions worse than anything Europe has to offer.

After a heavy rain, the field at Stanley, Nova Scotia, was so muddy that even a tractor (shown behind the oxen) was bogged down. A yoke of oxen was brought in to tow this trainer out of the mud. All operating conditions are not so difficult.


When time is of the essense
TIME TABLE
Defense Production
TIME TABLE
Airline Service
SAVE TIME BY AIR
DEPEND ON ....
Douglas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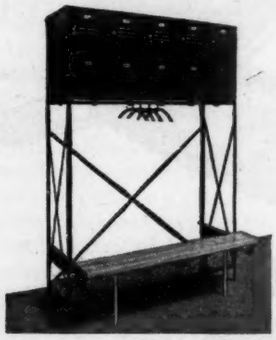
That Speed Defense!
For the total defense of America, the best is none too good, and we must make haste while the sun still shines. Here are two "short-cuts" to speed the program.

PENCO "3-Shift" Tool Stand
All-welded Steel Construction

Keep tools right on the job twenty-four hours a day. Each of the three drawers locks separately—a single drawer for each shift. Cuts tool losses. Amazing time-saver!



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More Books

WAR WINGS. *By David C. Cooke.* Published by Robert W. McBride & Co. 218 pages, illustrated, $2.75.

This book is for popular consumption. It is profusely illustrated and the text provides a running commentary to the captioned photographs. There is a fairly complete coverage of all military and naval types of aircraft of the American and British fighting forces. However, because of the rapid pace of development of military planes under wartime exigencies and the considerable number of new designs recently announced, the book does not include mention of some of the most interesting new military and naval aircraft. The captions are well written, pointing out interesting mechanical and aerodynamic features of the various types.

FLIGHT: AIRCRAFT ENGINES, A GENERAL SURVEY OF FUNDAMETALS OF AVIATION, *by Ray F. Kuns.* Published by American Technical Society, Chicago, Ill. 363 pages.

For a readable, easily understood book on aviation engines, written somewhat in the style of the *Book of Knowledge* sets, the beginner will find this volume of definite value. The material, while condensed, is not so packed with technical verbiage as to mystify, nor so general as to be impractical. A further aid are the numerous diagrams, drawings and cutaway photographs illustrating points made in the text; and, as has often been pointed out, a good picture is worth ten thousand words.

EFFECTIVE FOREMANSHIP. *Edited by Harold B. Maynard.* Published by McGraw-Hill Book Co. 263 pages, $2.50.

This work is the result of collaboration of fifteen experts on various phases of effective foremanship practice. It is thoroughly practical, yet fundamental principles underlying the methods of dealing with everyday problems of the foreman are carefully explained. It should prove equally valuable to the foreman who is just assuming his new responsibilities or to the experienced foreman who wants to improve his abilities.

Maynard is president of the Methods Engineering Council, Pittsburgh, Pa. The fourteen collaborators are men of widely varying talents, but all are recognized leaders in their respective fields of management, industrial engineering, education, plant layout, and so on. Throughout the text, actual examples illustrating the application of principles are utilized to enable the reader to quickly grasp and apply the suggestions and ideas under discussion.

INDUSTRIAL ACCIDENT PREVENTION, *by H. W. Heinrich.* McGraw-Hill Book Co., New York. 448 pages, $3.

The author is assistant superintendent of the engineering and inspection division of the Travelers Insurance Co. This is the second edition of his book, revised from the 1931 edition. The first edition was the standard work on accident prevention, and it is expected that this new edition will likewise gain wide acceptance in industry. It is pertinent to the aviation industry at this time because many plants have recently become large enough to see a need for safety education.

AIRCRAFT RECOGNITION, *by R. A. Saville-Sneath.* Published by Penguin Books, Harmondsworth, Middlesex, England, 174 pages.

Now that this country has aroused itself to the point of plucking speculatively at the curly beard of Mars, it would perhaps be just as well if we got down to the business of learning aircraft spotting. It may not be long, now, when a practical education in this subject will prove right handy.

For this purpose we could hardly do better than to begin our studies with this small pocket manual, the pages of which are packed with the practical information needed.

The first six chapters are devoted to familiarizing the student with various parts of airplanes in order that we may know where to look for certain distinctive points by which airplanes may be recognized. In the second part of the booklet, silhouettes and descriptive notes are given of the various aircraft now in service abroad, all of which, however, are not included.

A glossary of descriptive terms in the back will prove helpful in explaining terms like "aspect ratio" and "slab-sided" as applied to aircraft.

AVIATION INSURANCE MANUAL. Published by Aero Insurance Underwriters. Pocket size.

This is believed to be the first Manual ever published in connection with aviation insurance. It is a compact pocket-size booklet containing essential information for handling aviation coverages.

The Manual is divided into five different colored sections and is well indexed. A unique feature is a section containing a complete list of aircraft models and their present day prices.

Shipshape for Pursuit!

Swift and lethal as they look are the P-38 (Lockheed Lightning) pictured here and other U. S. Army pursuit ships. Similar American-built airplanes are now fighting with the R. A. F.

And, thanks to the in-line compactness of their Allison liquid-cooled engines, their designers had free rein to streamline them completely from tail to tip.

Thanks, too, to the cooperative efforts of our Army and aircraft industry, these highly advanced engines are now flowing out of the plant with ever-increasing production.

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Curtiss	*P-40*	*Tomahawk*
Lockheed	*P-38 Interceptor*	*Lightning*
North American	*Apache*	*Mustang*

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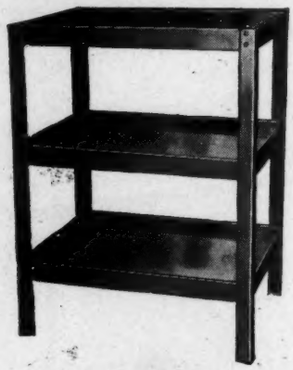

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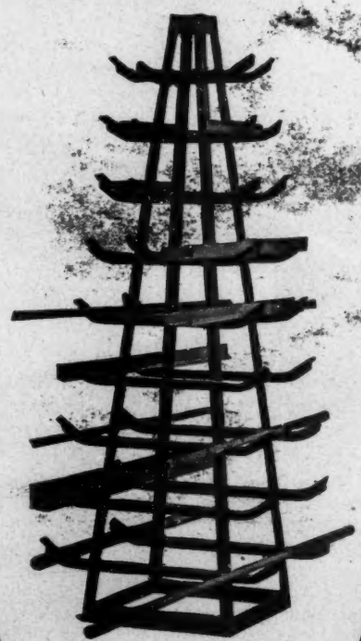

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The Steel Equipment People
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Maneuvers

(*Continued from page 57*)

then a swarm of Blue Douglas A-20A's would unload more flour sacks in another simulated bombardment. From the very outset Gen. Dargue used his pursuit superiority to embarrass Gen. Harmon, who was put to it to give properly escorted bomber support to his attacking Red Army while simultaneously defending with fighters the vulnerable bridgeheads created by the ground advance across the Red River.

More remarkable than the high operational standard of the air forces was their outstanding safety record. For instance, the Third Air Task Force had expected heavy casualties due to operation from makeshift fields around Lake Charles. However, Blue landing and takeoff fatalities were kept to 5, and of these, 3 were men in National Guard observation squadrons. In all, 10 men were lost—and this in spite of the fact that pursuit planes carried out their attacks on other formations with a realism and tenacity quite alarming to ground witnesses.

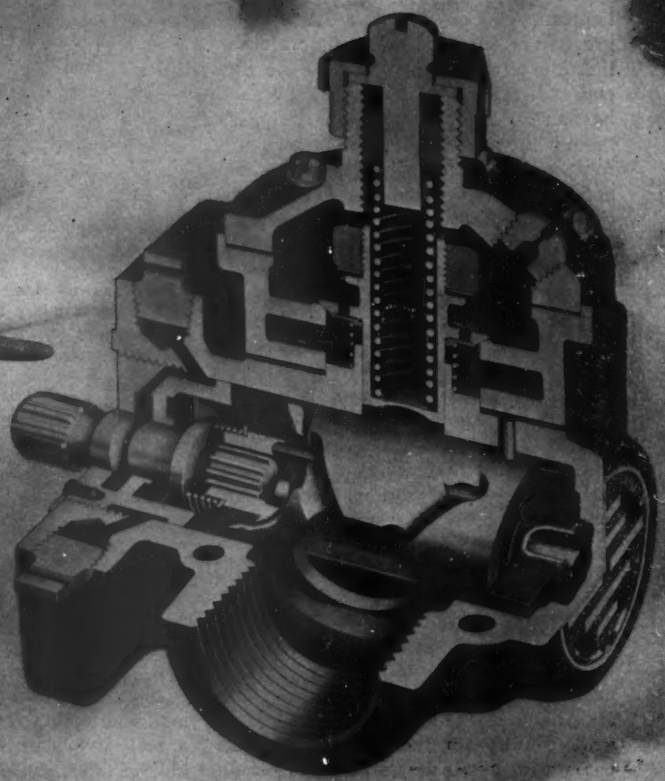
Credit for sustained and safe flying was attributable in no small part to the enthusiasm of maintenance crews and to the efficiency of organization. Typical was one crew of the First Observation Squadron. Though exhausted by a long day, they insisted on rushing through an unordered 100-hour check on a Stinson 0-49. The work began at midnight, and proceeded under semi-blackout conditions in a front-line sheep pasture from which the plane was temporarily operating. Such enthusiasm enabled this liaison squadron to fly an average of 22 hours, 7 minutes per day on tactical missions when otherwise paucity of planes would greatly have curtailed indoctrination of ground forces in the use of short-range air observation. In the GHQ phase alone, they flew 219 tactical missions for a total of 256 hours.

To obtain full realization of Air Corps safety achievement it is necessary to emphasize the point that flying crews often worked well beyond the point of maximum efficiency. A Red observation squadron using Stinsons was so anxious to serve the cavalry division to which they were attached that they managed regularly to pass the limit of two two-hour missions per day per crew. But so thorough had been training that even when fatigue caused pilot error, the airmen of this squadron were able to bank on their basic flying skill to redeem the situation. In taking off from a tree-bordered pasture, one pilot forgot to lower his Stinson's flaps, and yet got his ship out of the postage-stamp field undamaged. Although they operated throughout the entire maneuver period, this squadron's only mishap occurred when a plane rammed an undiscovered stump.

While praising the Air Task Forces and observation squadrons for their performance in the Louisiana maneuvers it is well to bear in mind that their work was only an indication of the high promise of the Air Corps—a promise of efficiency and power that can soon be realized if popular obsession for numerical strength does not interfere with sound expansion and training doctrine. In these same maneuvers there were many signs that haste and overgrowth can transform the Air Corps into an amorphous mass of unmilitary and unindoctrinated personnel. Already alarming is the fact that at no field did commanders compel dispersion of aircraft. Of course, the necessity for frequent flights from hopelessly overcrowded fields weighed against measures that would retard servicing. Nevertheless, in view of the fact that the vice of lining 'em up has cost Poland, Holland, Belgium, France and Yugoslavia their air forces, the observer must experience a pang of horror to see Army and Navy ships land and taxi up to form serried ranks, wing-tip to wing-tip. Certainly at the CAA field near Arcadia, where National Guard observation planes based, there was no reason for the planes to huddle like covies of quail. One end of Esler Field was especially camouflaged and fitted with tree-shaded revetments to protect three pursuit planes, yet the 21st Aviation Engineers had the greatest difficulty in inducing any pursuit to leave the concentration of planes around the hangar and take to the woods. Generally this Esler Field project and the camouflage installations at the Nachitoches airport failed to arouse proper interest. Visiting and native planes boiled in and out of Esler Field, but practically no one bothered to wander over and survey the progress the Engineers were making. Camouflaged dispersion facilities at the Red Nachitoches Field were better utilized, but so apathetic was the bulk of Red air force personnel that one generally learned of the engineers' work only by a visit to the field. Since second lieutenants today will two years hence be squadron leaders in command of such fields, this state of affairs is regrettable. It is more regrettable that the work done was attempted on a shoestring with insufficient time and not enough personnel.

Rather distressing to notice was the attitude of many reserve pilots towards the light planes which made their appearance in maneuvers. A young second

SIMPLIFIED DESIGN
FEWER PARTS
LESS WEIGHT



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Long recognized as standards of reliability and performance, PESCO Aircraft Fuel Pumps offer these important advantages:

- Simplified design—no snap rings, internal screws, rivets or similar bonds.
- Fewer parts to stock for replacement.
- Required periodic overhaul accomplished more readily.
- Maintenance cost reduced.
- Unusually low power consumption.
- High suction lift.
- Comparative oscillograph analysis indicates pressure pulsation as slight as those of more complicated design.
- Splined rotor-coupling engagement insures greater dependability and longer life.

COMPARE THESE FIGURES

PESCO Fuel Pump illustrated above compared with other makes of same output rating.

	No. of Parts*	Weight	Power Consumption
PESCO	32	3.0 lbs.	0.09 hp.
Pump A	40	3.2 lbs.	0.15 hp.
Pump B	42	3.28 lbs.	0.19 hp.
Pump C	33	3.0 lbs.	0.12 hp.

*Excluding screws, washers and tie wires.

STANDARD PESCO FUEL PUMPS FOR MODERN AIRCRAFT

PESCO Fuel Pump with diaphragm type relief valve (see large illustration above).

PESCO Fuel Pump with variable displacement, designed for high altitude flying.

PESCO Fuel Pump with relief valve in line and standard side ports.

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PESCO Low Capacity Fuel Pump specially designed for smaller planes.

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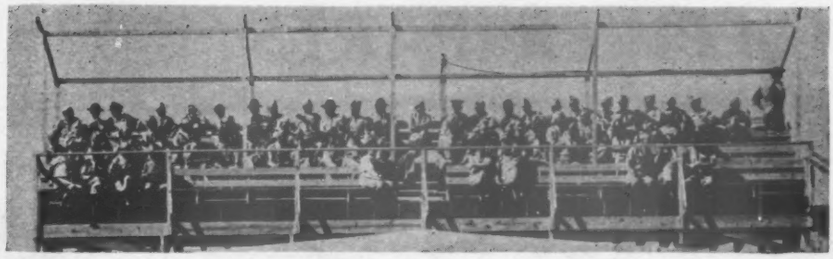
lieutenant delegated to fly a press photographer in one of these handy craft was literally terrified when he saw the tiny engine this Aeronca had. A P-40 man, he had no confidence in this ship, although it was furnished with parachutes for the two seats, with two-way radio and numerous instruments. The photographer, who was accustomed to flying Aeroncas, showed his flying credentials and attempted some elementary instruction on light planes, but the pursuit man would have none of it, and refused to believe that the ship wouldn't spin easily and would climb above 2500 feet. In the disinclination to use and appreciate the utility of cheap light planes there is some indication that the progressive spirit noticeable in older regular fliers is not always matched in the new, mass-produced reserves.

These and similar problems are minor and do not detract materially from the fine maneuver performance of the Air Task Forces and observation squadrons. The real shadow cast on this record is only indirectly a fault of the air units. But since the Air Corps is the air arm of the Army, it cannot escape responsibility for the failure to anticipate and cure the suicidal attitude displayed by ground rank and file towards air power. Following the wide popular trumpeting of the air menace, the average citizen might think that the new Army would be fully conscious of what air power can do. It is—when the topic is raised in conversation. In maneuvers it failed to translate this mental appreciation into concrete action. While maintaining better spacing than in former years between vehicles on the march, motorized troops consistently neglected to stop and dash for the shelter of neighboring fields and ditches when enemy planes came over. Few were the men who bothered to avail themselves of a real, live plane at which to practice aiming the protective machine guns. The trucks rolled placidly on, some of the men gawping at the bombers and fighters with never a thought of the charnel house that .50 calibre bullets would make of each vehicle along the line. Though the First Armored Division is considered an elite unit, in many cases its tanks and trucks would halt when on the march in a space between two trees. Either tree would have provided full concealment for anything parked beneath.



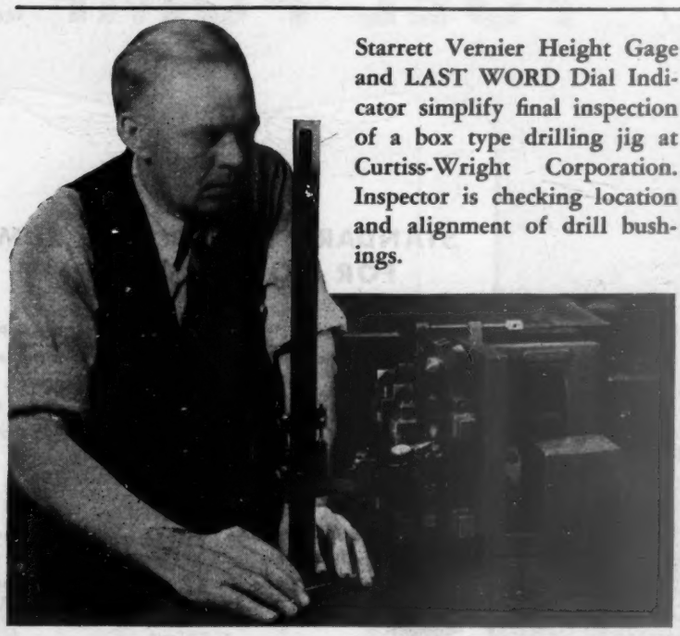
The Generals couldn't wait. During a specially staged show to prove devastating effect of bombing, many high officers of the ground forces were so little interested that they walked out on the show. This grandstand was built on top of a hangar at Barksdale Field. A total of over 4,000 officers were invited to this show.

When some attempt at camouflage was made, too frequently the camoufleur would forget that what is protected from ground observation is not necessarily hidden from the airman's prying eyes. Generally troops just didn't bother with real concealment from planes, and so ground forces could not only be bombed with great success, but observed with even greater profit.

Only the highest echelons exhibited a realistic grasp of air power. At most division and corps command posts the discipline and measures taken for protection against air action were so excellent as to appear freakish in comparison with the negligence of minor units. Message centers, staff tents and command cars were carefully scattered in thick woods, and at Gen. Patton's headquarters men's faces had to be turned down to avoid detection of activity whenever an air alarm was sounded.

Recognizing that carefully assessed maneuver "casualties" from air action really didn't impress ground rank and file in the slightest, the authorities sought to bring home vividly and convincingly the effect of air fire power. For this purpose a demonstration of air bombing and machine gunning was staged in the middle of the maneuvers. Invited were some 90 generals, and 4,000 junior officers. Because high winds retarded the schedule of this spectacular and informative show, many of the generals left their special grandstand before the affair had ended.

With apathy toward air power prevalent among ground forces, it is obvious that however well the Air Corps may fulfill the high promise it showed in the maneuvers, it cannot rest satisfied while there is danger that its supporting ground armies may be bombed and shot out from under it.



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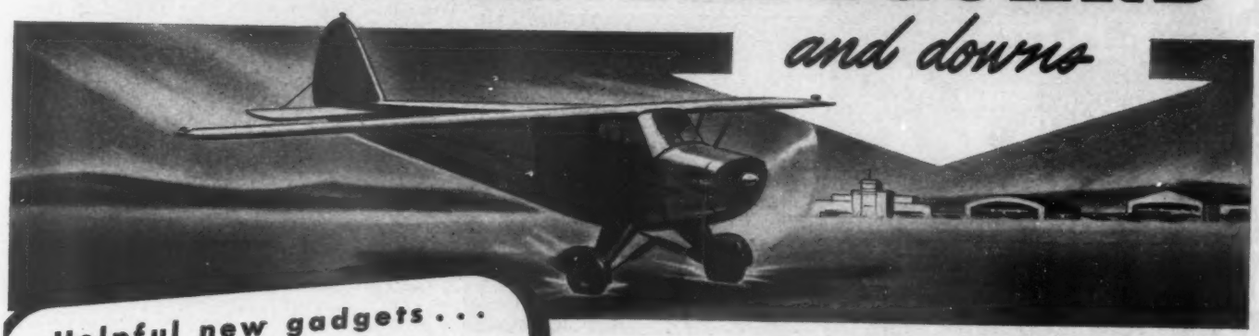

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GENERAL

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At left you see how they may be used fully extended with helmet, or collapsed to fit over the head-piece without helmet. Washable, sanitary, odorless.

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It won't let your antenna spin, twist or whip. The rubber cone can be quickly adjusted to the proper "drag." Length, 6½" . . . Diameter at Drag Spider, 4½". Never needs replacement.

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Put tires on your ship that will see you through . . . safeguard your life and your plane with General's three points of superiority:

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On big ships and little ships, use General Airplane Tires . . . first choice of thousands of military, commercial and sportsman pilots. You can purchase Generals from your fixed base operator.

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SIGNALS

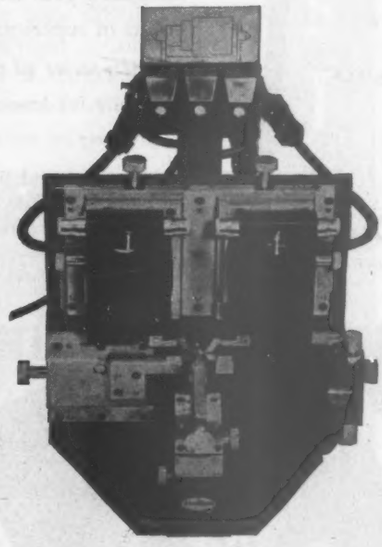
"Everything under control"

The Multichek Electrigage is like a battalion of U. S. troops. They quickly establish order and have everything under control. The Multichek Electrigages check a number of dimensions on a work part simultaneously, flashing the answers on a control panel.

This panel carries an elevation drawing of the work piece with each critical dimension shown. A signal light is provided for each of these dimensions.

A signal light showing red indicates its dimension is undersize, green an oversize dimension and amber that the dimension is truly within tolerance limits. When four or more measurements are being checked a master signal may be provided at the top of the panel to show white when all dimensions are correct. Thus the inspector looks only at the master signal unless it indicates trouble somewhere below.

Other models of this instrument are just as effective on extremely large shell bodies as this model is on small pinions less than a quarter of an inch long. Every part produced in large quantities which has several dimensions to be checked should be inspected on the Multichek Electrigage regardless of bulk.



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Aeronca

(*Continued from page 110*)

vator movement has been lightened by a change of leverage between the stick and the shaft. These changes are said to have resulted in a complete new system with finger tip control on the stick and easy rudder movements.

The fuselage has been widened four inches at the bottom of the cabin, thus increasing the cabin and seating arrangement. The student seated in the rear seat is still about 5 in. higher than the instructor in the front. Instruments have been rearranged with the altimeter and tachometer on the outer edges of the panel; airspeed has been moved to the center of the panel and the ignition switch is now on the right hand side of the cabin above the door where it is easily accessible to both occupants.

Standard brakes will be of the improved Shinn type that has been widely accepted and approved.

Flying Wing

(*Continued from page 83*)

the present "all-wing" design is another feature which has been thoroughly investigated. Although there is still much work to be done along this line it now appears that such auxiliary lift devices can be applied as effectively to this plane as to more conventional designs. One of the basic reasons for this is that the lift increase achieved by any means on the "all-wing" plane affects the entire plane, without considering the cancelling effect of auxiliary control surfaces, fuselage, etc., of the conventional plane. In our plane the entire wing lifts during normal flight.

Engineering of the present flying mock-up was begun in July, 1939 and first flight tests were made by Vance Breese from Muroc Dry Lake in July, 1940. After early tests had proved the plane to be satisfactory as to stability and control the flight test program was turned over to Moye W. Stephens, Secretary of Northrop Aircraft, Inc., who has now made more than 200 flights during the past year.

Further engineering and development work is now under way. We hope, when we are able to turn from the desperate urgency of present military work, to be able to demonstrate air transport planes of "all-wing" design which will have top speeds as much as 100 m.p.h. greater than will be possible with conventional designs of equal power and capacity.

*Oxygen masks protect North American test pilots on high-altitude test flights.

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AIRCRAFT FINISHES

Aircraft Maintenance

(Continued from page 59)

strategic points throughout the United Sattes. Some idea of the problem confronting these depots may be gained by a comparison of the problem to that of airline maintenance. Seventeen airlines operating approximately 500 transport aircraft require some 19 repair bases to overhaul and maintain their aircraft. Of these 19 bases, 7 will compare favorably with the smaller of the Air Corps repair depots. These bases include only the central overhaul facilities of the airlines and do not take into consideration the extensive service facilities required along the route of each line. Now, disregarding the smaller of the airline bases and assuming that the 7 large bases maintain all airline equipment, this would give us a ratio of one repair base to approximately 71 aircraft. This year the Air Corps will have over 12,000 aircraft! Assuming that under pressure each airline could handle the maintenance and overhaul of 200 aircraft, it would require 60 such maintenance bases to handle this year's production alone.

Of course, the Air Corps bases are being built on a scale more vast than has heretofore been dreamed of. But when one considers the number of engines, propellors, instruments, hydraulic units and thousands of other components which will require attention, some semblance of the magnitude of the Maintenance Command's responsibility may be had. There is apparently no limit to the number of aircraft to be built. As the number increases, the repair base problem grows in proportion. One solution to the problem in the future may be the establishment of large number of smaller yet completely equipped units. Such an arrangement would permit easier accessibility of the repair bases by the operating units.

At present the transport service supplies admirable service to the maintenance groups. The rapid transportation of equipment to be overhauled from the operations base to the maintenance depots is as much a part of the maintenance job as the overhaul of the equipment. The maintenance bases have probably not yet begun to feel the first heavy load imposed by the new group of production aircraft being delivered to the air forces. Engines in these aircraft have not yet reached the time limit before overhaul. Probably a great number of them will reach this period at approximately the same time and some semblance of war time requirements will be evidenced. Of course, the only answer to maintenance on such a large scale is the application of production methods. The Army, Navy and some of the airlines have operated on this basis before, but never on the scale that will be necessary to properly care for the huge number of aircraft being delivered.

One of the greatest problems of proper maintenance is the procurement and allocation of parts to the proper place at the proper time. Strangely enough, one small part can hold up a quarter of a million dollar aircraft which might be sorely needed for a tactical mission of importance. Certain parts required for operations maintenance such as spark plugs, brake discs, fuel hoses, lines, clamps, etc., fall in the category of those mentioned above. A careful study of the parts situation as applied to each type of aircraft will permit the formulation of a list which, if supplied to the operating units, will alleviate any possibility of delays due to parts shortages. The overhaul bases are, of course, the major source of supply of parts and our own Air Corps now has vast stores of spares for all aircraft and equipment being operated.

One of the biggest problems encountered in Britain in the operation of large numbers of new type aircraft has been that of untrained personnel. When one realizes that the mechanics whom we consider to be competent now gained their training over a number of years experience and that those now being enlisted come from the rank and file of lawyers, clerks, farmers, and other citizenry not likely to have had much experience with problems, it is easy to realize that one of the major contingencies with which we are confronted is that of training. In all probability it is infinitely better to specialize these new men inasmuch as it is easier to teach them how to care for one item of equipment thoroughly than to require them to spread their training over a large number of items of equipment. This would mean then that we would have specialists on engines, propellers, instruments, hydraulics, armament, and, in fact, on virtually every aircraft component, rather than have the old type of aircraft mechanic who was supposed to know everything.

The British are now sending many men to America for training and they certainly have not failed to realize the necessity for specialization. The United States Army Air Corps has not neglected this phase of preparation as they have undertaken a very intensive program of training a large number of men as aircraft mechanics. The manufacturers have contributed materially toward this training program by assisting in the arrangement of programs pertaining to their particular product. This could be carried even further by the establishment of units at the present Air Corps schools in large aircraft manufacturing centers.

Only a few of the problems connected with the establishment of a maintenance program to care for our new air force have been emphasized above. There are others just as large in their scope but perhaps not quite so interesting to study. For example, the supply and handling of fuel, oil and lubricants for the air force is a job which is without glamour and romance supposedly attached to aviation, yet is so vital to the operation of aircraft that poor planning or unsystematic handling would seriously impair the functioning of the air force. The tremendous amount of detail work in keeping records of overhaul time and the determination that engines arrive at repair bases at the proper time for overhaul is one which must be particularly well planned in order that the repair bases do not become bogged down with a large number of engines at one time.

These and many more problems constitute the huge job that has been given our Maintenance Command. The major problems are: (1) equipment and bases, (2) parts and parts distribution, (3) personnel, and (4) transport. Our Maintenance Command has attacked these problems with a vengeance and it is indeed gratifying to see that so difficult a task is being handled so skilfully in the beginning. This portends a smoothly functioning future for the maintenance of our aircraft. It is strange that a job so important and so difficult receives so little publicity and ballyhoo, yet the type of men required to accomplish a job like this are usually those who shy from just such recognition.

Certainly we are well on our way towards the largest and finest air force in the world backed by the most complete and able maintenance organization ever conceived.

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"Stop Dust With The Dustkop"—is title of a 4-page folder showing compact, low cost, self-contained unit dust collectors. Specifications, cutaway showing construction, together with illustrations of unit used with grinders. Aget-Detroit Mfg. Co., Book Bldg., Detroit, Mich.

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AMERICAN CABLE *Korōdless* AIRCRAFT CONTROLS

Air Filters

(*Continued from page 115*)

by the filter fairly evenly throughout the entire depth of the filter media and thereby provide maximum dust-holding capacity with minimum rise in resistance. Such a filter, if properly made, should last virtually as long as the plane in which it is mounted. It can be cleaned by washing in gasoline, and oiled by dipping in airplane engine lubricating oil, both of which are readily available at any air base. The only additional equipment required for maintenance is a small supply of spare filter cells and suitable tanks for washing and charging the filters; so the transportation and maintenance problem is reduced to an absolute minimum.

The development of a suitable viscous impingement type filter which provides maximum cleaning efficiency, maximum dust-holding capacity and minimum weight and size presented a very interesting research problem. The filtration of air is a rather new art and was started only 20 years or so ago, but during that time certain standard practices have developed in applying air filters to ventilating and air conditioning service. For instance, it has been customary to limit the velocity of air flow through the free area of viscous impingement type filters to a maximum of 350 f.p.m., and to make the filters approximately 4 in. thick. The resistance to air flow had to be kept low (½ in. to ¾ in. w.g. when dirty) because the blowers used in ventilation service are incapable of overcoming high resistance, and filters had to have a sufficient dust-holding capacity to operate under normal dust conditions for a period of from 4 to 6 weeks before cleaning was necessary in order to keep their maintenance cost within reasonable limits. In designing a filter for military airplane service, however, it was necessary to disregard standard practice for ventilating and air conditioning service, and virtually start from scratch in an attempt to develop a thinner filter which would afford satisfactory protection at much higher air velocities, thereby reducing both the weight and the size of the filter unit. After consultation with various airplane manufacturers and government officials, the following fundamental specifications for airplane filters were established:

(1) Maximum permissible resistance when dirty—4 in. w.g.
(2) Minimum permissible efficiency —90 percent.

Having established these two limits, the performance of a filter, therefore, may be judged by the velocity of air flow and the amount of dust it is capable of accumulating before the resistance exceeds 4 in. w.g. or the efficiency drops below 90 percent. As a general rule, the efficiency proves to be the determining factor, and most of the filters tested dropped below 90 percent efficiency before the resistance reached 4 in. w.g.

With the idea of making a filter having the absolute minimum thickness, much of the original research was devoted to the development of a filter ¾ in. thick. Referring to Fig. 2, the curves marked "A" and "B" indicate the performance of two of the best ¾ in. thick filters developed. It will be noted that filter "A" dropped below 90 percent efficiency after accumulating a dust load of approximately 198 grams per sq. ft. Filter "B", another ¾ in. filter of somewhat different design, accumulated 252 grams per sq. ft. before the efficiency dropped below 90 percent, which is an improvement on filter "A", but is very poor when compared to filter "C" which is 2 in. thick. Filter "C" drops below 90 percent efficiency only after 954 grams per sq. ft. have been accumulated. The best ¾ in. thick filter (filter "B") therefore has only about 25 percent the dust-holding capacity of filter "C" when operated under parallel conditions. All tests indicated in Fig. 2 were made with a dust concentration of .03 grams per cu. ft. and an air velocity of 600 f.p.m. through the free area.

When the use of air filters on military planes was first being considered, it was thought that a velocity of 600 f.p.m. through the free area would be about the maximum which could be used, but in view of the much superior performance of the 2 in. thick filter over the ¾ in. thick unit, as indicated in Fig. 2, the possibility of using higher air velocities became evident.

Fig. 3 shows the comparative performance of the best ¾ in. filter with air velocity of 600 f.p.m. (curves "D") and two somewhat different 2 in. thick filters at velocities of 900 f.p.m. and 1,000 f.p.m. Referring again to fundamental specifications that the resistance must not exceed 4 in. w.g. and the efficiency must not drop below 90 percent, it is evident from these curves that filter "D" with air velocity of 600 f.p.m. falls below efficiency requirements after 14 minutes; filter "E" with air velocity of 900 f.p.m. is good for 30 minutes; and filter "F" with air velocity of 1,000 f.p.m. is also good for 30 minutes. The overall efficiency of filter "F" is considerably better than filter "E" and it is, therefore, preferable from the standpoint of both efficiency and the space required for its installation.

From the standpoint of weight, filter "F" compares favorably with the other filters if an air velocity of 1,000 f.p.m. is employed. As an illustration, an 1800 h.p. engine requires approximately 2700 c.f.m. (1.5 c.f.m. per h.p.). If filter "D" is used with velocity of 600 f.p.m., a net area of 4.5 sq. inches would be required, and such a filter would weigh approximately 11½ lbs. If filter "E" is used with a velocity of 900 f.p.m., a net area of 3 sq.ft. would be required, and this filter would weigh approximately 12.2 lbs. With filter "F" employing a velocity of 1,000 f.p.m., a net area of 2.7 sq.ft. would be required, and filter would weigh approximately 11.8 lbs.

The following tabulation will give a general idea of the comparative costs of the three filters for handling the same air volume at the velocities indicated:

Filter	Velocity of Air Flow	Filter Media	List Price	% Cost, Filter "F"	% Area Filter "D"	% of Weight Filter "E"
D	600 f.p.m.	UM-153	$26.00	87	100	95
E	900 f.p.m.	UM-152	28.50	95	66⅔	100
F	1000 f.p.m.	UM-155	30.00	100	60	97.4

Fig. 4

In view of this small difference in cost and the much superior performance of filter "F" its use in preference to the other units would seem logical, especially in view of the fact that it requires less space than either of the others.

Material and Construction

Some of the original air filters made for airplane service were provided with aluminum channel frames in order to reduce weight to a minimum. It was found, however, that with the rough handling air filters frequently receive steel channels hold up much better, especially at the corners where they are welded. The cost is less and by using 20-gage steel instead of 16 or 18-gage aluminum, it is possible to obtain a more rugged filter without materially increasing the weight.

The filter media used in all the air filters developed (with the exception of filter "A", Fig. 2) is a combination of knit steel wire and knit copper ribbon. The knit steel wire is placed on the air-entering side, and the first few layers are crimped in order to provide space between the individual strands of media which will permit a considerable amount of dust to accumulate without blocking off a large percentage of the air passage. These crimped layers of media are followed by flat layers of knit steel wire which forms a more dense section, and a still more dense section is formed by the woven copper ribbon. Again referring

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to Fig. 3, the superior performance of filter "F" over filter "E" was obtained by adding 8 more layers of crimped and flat knit steel wire. In addition to improving the efficiency and permitting higher air velocity, crowding this extra media into this 2 in. space will result in better wearing qualities. The reason for this is that these filters will be subjected to considerable vibration, and the more tightly the individual layers of media are pressed against each other, the less opportunity they will have to move and cause wear by rubbing.

Installation in Airplanes

The size air filter required for an airplane engine is determined by the following procedure. It is first necessary to determine the cubic feet of air to be handled, and the usual practice is to figure 1.5 c.f.m. per h.p. at military or take-off power, whichever is the higher. The next step is to decide on the type of air filter to be employed and select a velocity of air flow for this filter which will give satisfactory performance. The net filter area required is then determined by dividing the c.f.m. by the velocity of air flow, and after this is calculated the dimensions of a filter which will give this net area can be determined by the space available for mounting. As far as possible, air filters should be of rectangular shape and must be absolutely flat.

Air filters may be installed at any convenient point between the air intake and the carburetor, and this is a problem primarily for the airplane manufacturer to solve. Many installations are being made directly in the air scoops. Filters so installed should be mounted in such a manner that loose dirt particles will tend to fall away from the filter panel, and suitable means such as slots or tubes should be provided to carry overboard any dust that collects in the duct on the up-stream side of the filter. The size and number of such slots, however, should be held to a minimum to avoid excess loss in ram.

On installations in which turbo superchargers are used, the filter may be installed either before or after the supercharger. The consensus, however, seems to be in favor of installing them after the supercharger and intercooler. The only disadvantage with such an installation is that the supercharger is not protected from the abrasive effect of the dust, although from information now available no appreciable wear has occurred on superchargers under conditions which caused severe engine wear. *A bypass around the air filter is essential when it is installed in a position where it may become stopped up by snow or ice.*

No means need be provided for bypassing air around the filter if the hot air intake connects directly to the carburetor without going through the filter, but it is important that no heated air should be passed through the filter. Filter should be accessible for servicing with the removal of a minimum amount of cowling. Rapid acting fasteners should be used to hold filter channels in place except when the filters are installed on the pressure side of the supercharger, in which case the use of a limited number of screws is permissible.

Summary and Conclusions

(1) Tabulated below are the various characteristics of a viscous impingement type air filter which deserve special consideration, in the order of importance:

(a) Ability to maintain a high cleaning efficiency even after a large amount of dust has been accumulated.

(b) Strength of construction and ability to withstand frequent and rough handling—Permanency.

(c) Size—Space required for installing.

(d) Weight.

(e) First cost.

(2) The superiority of filters 2 in. thick over filters ¾ in. thick is definitely indicated.

(3) Of the 30 or more filters made and tested, filter designated as UM-155 (Filter "C" Fig. 2 and Filter "F" Fig. 3) is by far the best, and costs very little more than inferior designs. An interesting sidelight in this connection is the fact that filter "E" and filter "F" are identical in external appearance, which goes to show that you can't tell much about an air filter just by looking at it.

(4) It is the opinion of some authorities that a filter should be able to operate for a minimum period of 30 minutes with a concentration of .03 grams of dust per cu. ft. of air handled, without exceeding 4 in. w.g. and without dropping below 90 percent in cleaning efficiency. Filter "D" does not meet this requirement even with a velocity of only 600 f.p.m. Filter "E" barely qualifies at 900 f.p.m., and filter "F" barely qualifies at 1000 f.p.m.

(5) Improved performance can be obtained from any of the filters tested by using somewhat lower velocities than those for which curves are shown in Fig. 3.

(6) Test results are influenced by a number of factors other than filter design, such as (a) temperature, (b) viscosity of oil used, (c) specific gravity and particle size of dust, (d) test procedure, and (e) dust concentration per cu. ft. These five possible variables were controlled as indicated below:

(a) All tests were made at temperatures varying from 60 deg. to 80 deg. F.

(b) 120-second (Saybolt Universal Viscometer at 210 deg. F.) airplane engine lubricating oil was used for charging the filters being tested.

(c) Portland Cement was employed as the test dust. Dust was first dried and then screened for a sufficient time to get 100 percent through the 100-mesh screen and at least 50 percent through the 325-mesh screen.

(d) Uniform procedure was followed on all tests covered by this report. For details see "Supplementary Data."

(e) Dust concentration was maintained at .03 grams per cu. ft. regardless of air velocity, by use of an automatic dust feeder of the vibration type which fed a uniform mixture of fine and coarse dust particles.

Supplementary Data
Apparatus and Test Procedure

The apparatus consisted of a duct of sufficient length to obtain proper air distribution and mixing of the dust and air, of a size and design to take an 8 in. x 9⅛ in. filter either ¾ in. or 2 in. thick. The duct was connected to a high pressure blower and had a damper to control the amount of air which the blower pulled through the system. Inclined draft gages were used for measuring the resistance or pressure drop across the filter, and for measuring the pressure drop across the calibrated orifice placed at the entrance of the duct to measure quantity of air flowing in the system. The test dust was introduced by a vibration type dust feeder in such quantities that a uniform dust concentration of .03 grams per cu. ft. of air was obtained. A balance was used to weigh the filter and the dust fed into the system.

The filter to be tested was dipped in 120-second (Saybolt Universal Viscometer at 210 deg. F.) airplane engine lubricating oil and allowed to drain over night. It was then weighed and placed in the test apparatus. The proper amount of dust to give a dust concentration of .03 grams per cu. ft. at the rate of air flow employed for a period of ten minutes was weighed out. The test was then started and conducted for ten minutes. The filter was then removed from the system and weighed. The dust that settled out in the duct in front of the filter was removed and weighed and this weight subtracted from the weight of the dust fed into the system to obtain the actual amount of dust entering the filter. The efficiency of the filter was then determined by dividing the weight of the dust caught by the weight of dust actually entering the filter cell. At least three such ten minute tests were made on each filter. The test dust employed was Speed Portland cement, all of which passed through 100-mesh screen and at least 50 percent of which passed through 325-mesh screen. Dust was dried by heating at 215 deg. F. before screening for a sufficient length of time to drive out all moisture.

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Welding Procedure

(Continued from page 117)

stance for which it is desirable is the attachment of a thin gusset plate by means of a fillet weld. "Scale" welding is naturally slower than either forehand or backhand, but does have the advantage of causing less distortion. *It should not be used except for those special purposes for which it was developed.*

The most important precaution regarding "scale" welding is to keep the weld protected by the flame envelope at all times. When allowing each succeeding weld to solidify, draw the flame *back along the line of the flame.* Do not flick it off to one side.

4. Qualification of the Welding Operator To Follow the Procedure.

In many respects this is the most important part of the procedure control. In welding shops of plants not using a procedure control, practically every welding operator uses a slightly different technique from the rest. Some always use forehand welding, others always "scale" weld. Flame adjustment is far from uniform and ranges all the way from slight excess acetylene to definitely oxidizing adjustments. Some operators allow the puddle to flow forward onto solid metal and then attempt to "dig it in" by dipping the inner cone deep into the puddle. Some operators start a puddle and, instead of keeping it uniform in size, allow it to grow continuously larger. When it appears that the puddle will get out of control, they flick the flame off to the side to allow it to cool, and, of course, thus expose the molten metal to the oxygen of the air. Frequently operators doing "scale" welding expose each successive weld puddle to the air. After observing such variations in welding technique, it becomes no longer a source of wonder that the welding results are not uniform. The fault lies in the lack of definite control. The proof in this statement is that in those plants having a definite procedure control, consistently good results are obtained.

5. Inspection and Testing of Completed Work.

The most widely used testing method for completed work in aircraft is the Magnaflux test. The principle on which this test is based is that an electric current passing through a conductor sets up a magnetic field. Any discontinuity in structure of the conductor will cause a change in the lines of magnetic flux, and this change can be indicated by small magnetic substances, such as iron filings.

In the practical application to aircraft, an electric current is passed through a part at relatively low voltage and the part is either submerged in a tank having iron filings suspended in kerosene or liquid from the tank is pumped over the part. A visual examination will reveal cracks at or near the surface of defective parts because of the concentration of iron filings at such points. In some plants parts are given a coat of light green paint before testing as this aids the inspector in seeing the filings.

Jigs and Fixtures.

As has already been mentioned, the design of jigs and fixtures is rightfully a part of procedure control. This function should be performed under the direction of the welding supervisor, even if the actual construction work is performed by a separate department.

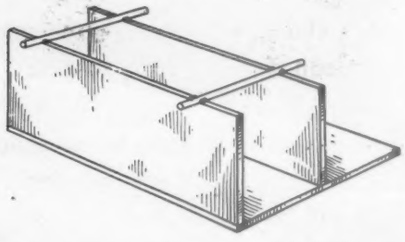

Fig. 12—Here sections of welding tack-welded to the upright sheets act as a jig. Such a procedure should never be used on tubing. Unless the part is to be heat-treated after welding, the welding should be allowed to touch tubing only where welds are to be made.

Jig design is a broad subject, perhaps as broad as the subject of design of the structural parts. Therefore, a few general suggestions are all that can be given here.

A jig should be designed with thought to the properties of the material being welded. S.A.E. X4130 is air-hardened. Any large masses of jig close to a weld will serve to hasten the quenching of the weld and, sometimes, may increase the tendency to form less ductile zones.

Oxy-acetylene welding can be done in any position, but the most consistent results will be found in those welds which are made in the flat position. It becomes advisable, therefore, to make all jigs so that they also become positioning fixtures.

The design of jigs for motor mounts, for instance, varies widely from plant to plant. Some jigs require the operator to make some welds lying on his back, welding in the overhead position through a small hole in the bed plate of the jig. In others the man must crawl into the most awkward position to complete the work.

The best jigs for motor mounts are those which make it possible to weld in the flat position, or nearly so, at all times while the operator is in a comfortable position. Such jigs cost somewhat more but are justified from both the standpoint of the amount and the quality of the work done in them.

The subject of operator comfort receives considerable attention in those plants doing consistently good work. It is inefficient to require a man to assume awkward and tiring positions. He obviously cannot do his best work. Stools of various heights best suited to the work should be provided wherever possible.

Another point regarding jigs which should be stressed is the method of clamping. Quick-acting clamps are best. These require less time for mounting materials and often make it possible to hold parts fairly rigidly during welding itself and yet release the stress while the material cools through the brittle range.

In one plant, small box-like parts are tack-welded in a jig but removed for welding. To minimize distortion during welding, short lengths of welding rod are added to support the parts. After welding, these are melted off. This method is excellent when welded to the edges of sheets, but should not be used to support tubular structures. The amount of welding performed on any tube should be kept to a minimum. If the designer has located the welds at the point of least service stress, his efforts may be nullified by any welding done at other points.

In conclusion it should be stressed that consistently good results from a welding department are assured when management: (1) designs for welding; (2) establishes a procedure which will give the results expected; (3) and qualifies the welding operators to follow that procedure.

Important Precautions for Operators

1. *Use no oil.* Do not handle equipment with greasy hands or gloves.
2. Use a slightly excess acetylene or neutral flame for steel welding—never fan oxidizing flame.
3. Never do any welding or cutting on containers that have held a flammable substance until they have been thoroughly cleaned and safeguarded.
4. Have equipment inspected at frequent intervals.
5. Do not use blowpipes, regulators, or other oxy-acetylene equipment in need of repair.

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You've watched your son's interest in aviation grow from early childhood. You've seen him build model airplanes, watched him pore over aviation magazines. The day he told you, "I want to learn how to fly," you understood.

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The school your son chooses is of vital importance. The school is truly the cradle of the aviation industry. If your son gets the right kind of training at the *beginning* of his career, his opportunities for employment and rapid advancement will be greatly enhanced. This is why he should select a well-established, government-approved school that is recognized in the industry.

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PRESIDENT.

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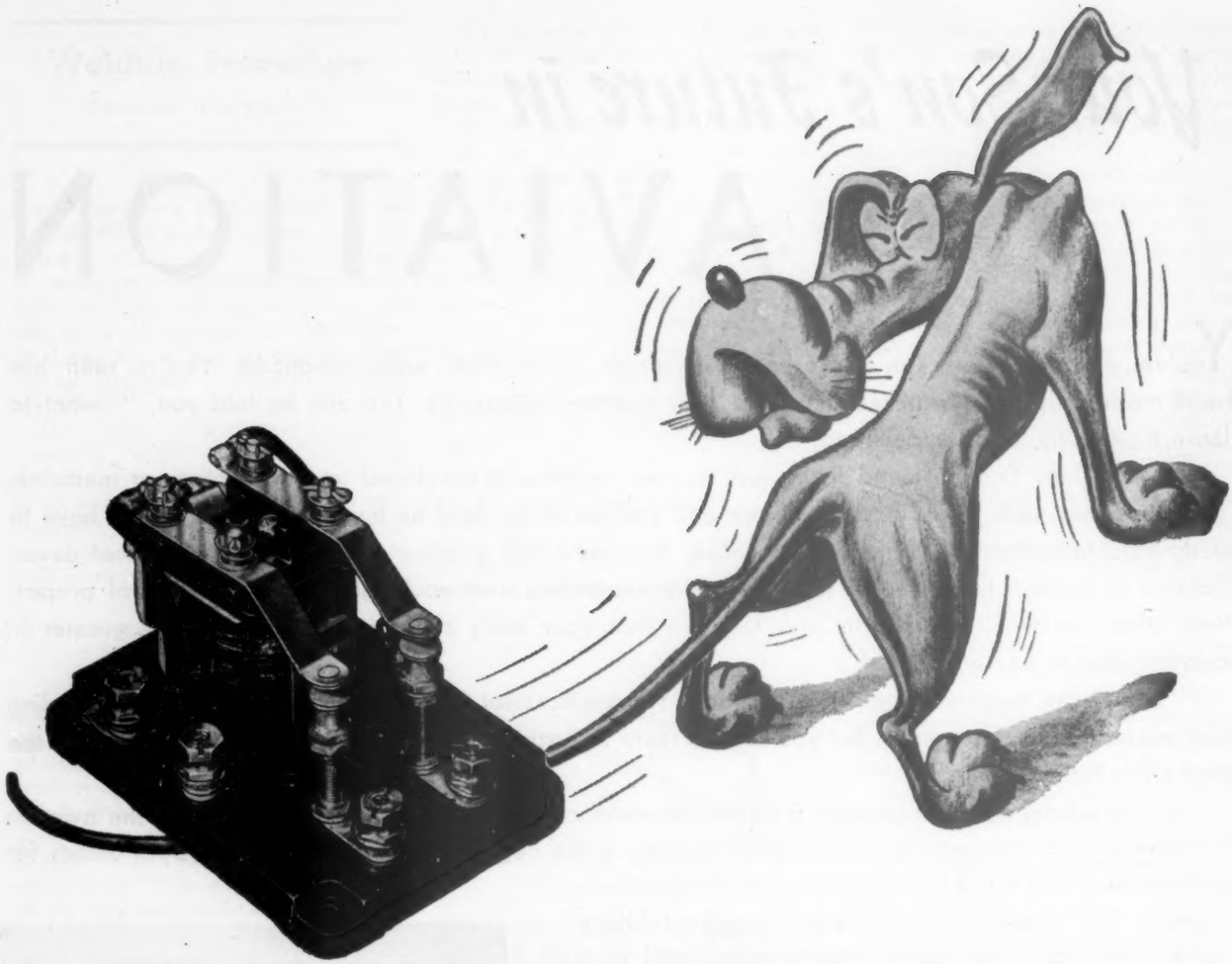

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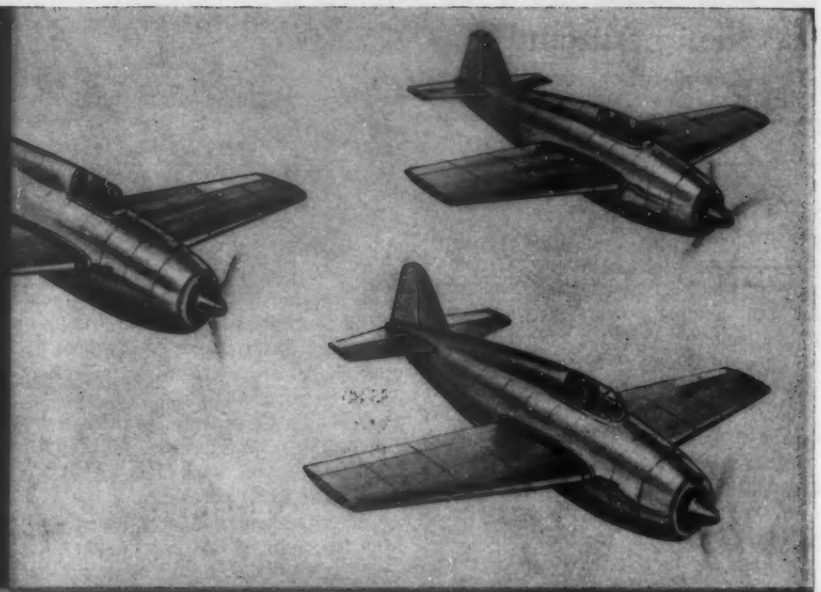

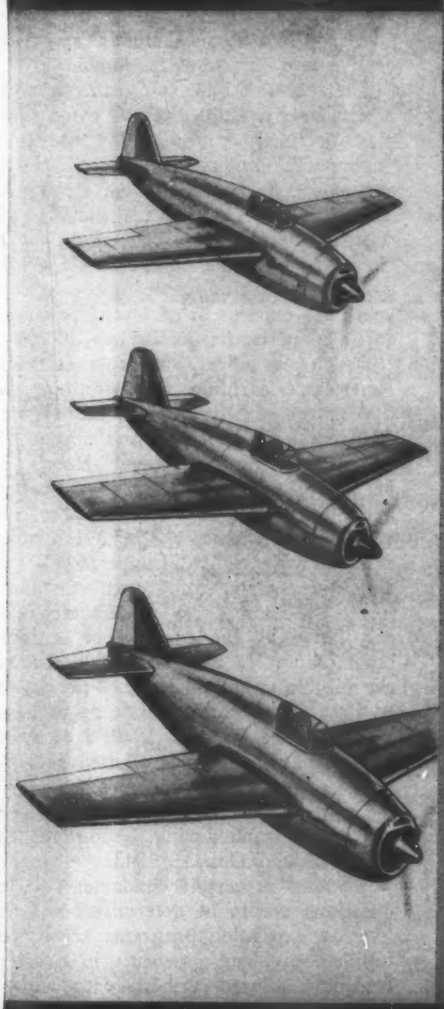

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Selig Altschul

(Continued from page 126)

earnings statement reveals one reason for the lack of investor support. TWA will be the only major carrier to finish the year at a loss, despite the benefit of increased mail compensation. The company has had a difficult time developing any real earning power. It is necessary to go back to 1936 for the company's most profitable year when it showed a net income of $205,000. For the years 1937, 1938 and 1940, an aggregate net deficit of about $2,000,000 was reported. (A retroactive mail rate adjustment of about $400,000 converted a 1939 loss into a small profit). With its revenues bolstered by income received from training pilots for the U. S. Army Air Corps and the British, there was some hope that TWA might make the profit column for 1941; however, the company will have to try again next year.

TWA, in an effort to expand its routes, has formed a new air line corporation with the New Haven railroad. Control of the new corporation to be known as TWA-New England, Inc. will be held by TWA with a 55 percent stock ownership. In addition for a route between New York and Boston, this new combine plans to apply for routes throughout the southern New England territory. As with all new route applications, these petitions promise to take a long time before granted—if at all.

The association of TWA with a railroad in this venture recalls an interesting sidelight on the air line's origin. The nucleus of TWA was formed in 1929 under the financial aegis of the Pennsylvania Railroad. Originally investing $502,000 in this enterprise, the railroad ultimately sold its interest at a sizeable loss. An officer of the railroad, however, has continued on TWA's board of directors. This new railroad affiliation should rekindle old family ties as the Pennsylvania Railroad interests own about one-fifth of the common stock of the New York, New Haven and Hartford Railroad Co.

Other aspects of TWA's early financial history may be of further interest in view of recent developments. In 1935, financial control of TWA was purchased by Lehman Brothers from General Motors. Early in 1939, Howard Hughes purchased Lehman's approximately 100,000 shares of TWA and control. The records and published reports indicate that the net result of the transaction was an estimated loss of more than $300,000 to Lehman Brothers.

This same banking firm has again indicated its interest in the domestic air transport industry by becoming interested in two of the smaller lines. National Airlines received financial assistance from Lehman Brothers along with business advice. In part consideration, the air line has granted the bankers an option to purchase 10,000 shares at $7.50 per share at any time before April 15, 1944. At the present price of the stock, this option is of no tangible value. However, much can happen in two and one-half years.

In March, 1941, Lehman Brothers also entered into a purchase agreement with Continental Air Lines, Inc., purchasing 50,000 shares of stock at $7.75 per share, to be offered to the public at $3.80 per share. In consideration of this agreement, Continental granted Lehman an option to purchase an additional 12,500 shares of stock for a four year period at $3.80 per share.

This participation of a leading banking house in two of the smaller lines is indicative of the broadening interest in the securities of all of the air lines. At the present time, every domestic air transport company, except one, has securities outstanding in the hands of the public. As recent as two years ago, the investing public confined its interest, for the most part, to issues listed on the exchanges. These were few in number. However, as the industry became more firmly established and the individual lines began to develop some earning power, the public was "invited" to participate in the ownership of these various companies. As a result, the last year or so has seen many offerings of stocks of companies previously owned entirely by the pioneer founders. The pioneers", in most instances, have found it profitable to sell part of their holdings.

TABLE I

Capitalizations and Markets—Domestic Air Lines

	*Approx. Market	1941 High	1941 Low	Listed or Traded	†Common Stock Out-Stand. (Shares)
American	51¼	58¼	40	NYS	575,000
Braniff	4¼	5¼	4¼	OTC	400,000
Canadian-Colonial	2¼	5	2¼	NYC	260,000
Chicago & Southern	4¼	6¼	3¼	OTC	167,730
Continental	4	4¼	2¼	OTC	250,906
Delta	9	9	8¼	OTC	198,384
Eastern	29¼	34	24	NYS	572,178
Mid-Continent	3	3¼	2	OTC	388,799
National	5¼	7	5¼	OTC	270,000
Northeast	3¼	3¼	3¼	OTC	300,000
Northwest	12¼	14	7¼	NYS	234,920
Penn-Central	10	14¼	8¼	NYC	331,790
TWA	12¼	17¼	9¼	NYS	950,000
United	14	17¼	9¼	NYS	1,500,451
Western	3¼	5¼	3¼	NYC	409,954

Notes

NYS—New York Stock Exchange
NYC—New York Curb Exchange
OTC—Over-the-counter—(Bids used)
*As of Nov. 7, 1941
†Excludes any preferred stock or options

Barron's Stock Averages

	Aircraft	Air Transport	50 Stocks
Nov. 7, 1941	35.92	23.94	68
Oct. 31, 1941	36.30	23.03	68
Oct. 24, 1941	37.08	23.72	68
Oct. 17, 1941	35.58	22.50	68
Oct. 10, 1941	36.08	22.81	70
Nov. 8, 1940	41.70	29.44	82

Illustrating the extent of the public interest in air transport stocks, the first complete up-to-date summary of all air lines ever compiled in such manner is presented in Table I. The basic capitalizations, together with the market ranges for this year, are presented for every company that has securities outstanding in the hands of the public regardless if the issue is listed on a national exchange or traded "over-the-counter". Moreover, this table also affords a comparison of the market action of each issue during the year. In most instances, the market prices were higher during 1939 and 1940.

The only domestic air line which failed to make any public offering of securities throughout this period was Inland Air Lines, Inc. The reason may not be difficult to find when looking at the company's earnings trend. For example, while every line has shown consistent gains in gross passenger revenues, particularly during the summer months, Inland actually reported declines for July and September.

The action of Pan American Airways in declaring a $1.00 dividend came as a pleasant surprise to the financial community. The last payment was 25 cents per share, made in November, 1938. This disbursement reflects the improved status of the company's operations. This stock has also been in the forefront of the group making new highs for the year. At current price levels, it is up about 80 percent from its low of 10.

Despite its expansion expenses, Pan American's earnings are definitely on the uptrend this year. Net income for 1940 totaled $2,256,318 and surpassed 1939 results by 12 percent. However, per share earnings were lower—being $1.19 in 1940 and $1.46 the previous year. In March, 1940, 525,391 shares of stock were sold to provide $6,250,000 and increased the total stock outstanding to 1,887,355 shares. This equity will be diluted by the exercise of options outstanding. A total of 50,000 shares are subject to option at $12.50 per share to Pres. Trippe at any time up to Feb. 28, 1942. At Dec. 31, 1940, a total of 62,645 shares were also allotted in connection with the company's management stock purchase plan at $12.50 per share exercisable during the four month period to end Oct. 31, 1943.

As long as certain fundamental rate questions are to be determined and as long as expansion programs are to be fulfilled, dividend payments in the air transport industry are likely to be deferred or substantially reduced. Regular payments, however, are being made on the preferred stock outstanding by two companies: American and Chicago & Southern. During 1940 the only such payment made was by American Airlines to the extent of $1.00 per share on its common stock.

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Light Plane Maintenance

(*Continued from page 73*)

from all parts of the Nation, cover approximately 3500 airplanes. They cover operations at airports located from sea level to more than 7000 feet above sea level, from airports which require operations on skis as early as October to airports where it never freezes, from airports in the dust bowl with unsurfaced runways to all-way airports covered with blue-grass, and to those with beautifully paved runways. These maintenance reports describe airplanes of operators whose business policy is to avoid spending money for repairs as long as possible to operators who believe in the axiom, "A stitch in time saves nine." These reports come in to Washington from the regions and present a story of almost limitless possibilities. It is the responsibility of those who review these reports to read that story. It is their responsibility to learn from the reports things which might be done to give some help to each, or any, of the three musketeers.

Sectional Differences

Certain incidents seem to happen in various parts of the country to certain airplanes. When things happen like that, the answer is easy because the failure is contingent upon very special conditions. Often, airplane "A" is subject to failures to which airplanes "B," "C," and "D" are immune. Again the answer is easy because that particular type of trouble is one that "B," "C," and "D" have either overcome or avoided. "A" is told of the existence of this trouble and finds little difficulty in overcoming it. The Washington reviewers of maintenance reports notify the manufacturers involved, suggesting a remedy when it is apparent. The manufacturers, after assuring themselves that the proper remedy is developed, send bulletins to the flight contractors indicating the corrections. If these corrections are of importance to safety and the proper performance of the airplane, the Aircraft Engineering Division of the Civil Aeronautics Administration makes it mandatory for the operator to comply with the bulletins.

The study of these epidemics, or chronic ills, is extremely interesting. Frequently they occur only under one operating condition, or a combination of operating conditions. Sometimes they pertain to faulty design on the part of one manufacturer, which might show up as a welded joint which cracks in too many of his airplanes, or in frayed control cables which rub too hard in the fairleads, or perhaps the hinges of a tail surface develop defects similarly in too many cases. The cures for such as the above are simple. In the case of an improper weld, members are made of different material, or the welds webbed, or made larger. Control cables are rerouted slightly to reduce rubbing. The hinges of the tail surfaces are redesigned to serve better.

Faulty Operation

Sometimes the ills are due to faulty operation; and when operation is at fault the first thing noticed is that the ills do not confine themselves to any particular airplane or any particular section of the country. Essentially they consist largely of those ills which are to be expected when engines are not properly warmed before take-off, when throttles are wide open all the time, and when regular and frequent maintenance inspections are not made by the operator's mechanic. Pilot and mechanic carelessness accounts for many engine ailments. Many broken landing gears, and airplanes out of proper rig. These are perhaps the most difficult ill for us to cure. They are cancerous in their persistence! Careless men just will be careless men! Our recourse is to inform the operators and our regional supervisors about the existence of these ills and the importance of curing them; and then to see that if improvement is not shown in the operations wherein dangerous carelessness is practiced they, the contractors, do not continue to contract for flight training with the Government.

Ills due to maintenance frequently show up in the log book as irregular and too infrequent airplane and engine checks. They also show up as forced landings due to running out of gas or oil. Faulty condition of the ship and engine is so apparent to our regional supervisors that frequently we can effect a remedy before a mechanical failure occurs—a case where we may "lock the barn before the horse is stolen." However, the means of effecting improved general conditions of maintenance are similar to those we must apply to faulty operation—that is; education, education, and again education; and if we are unsuccessful in this, to leave the operator by the way side.

Maintenance Saves Money

Thousands of dollars have been needlessly spent for replacement parts which would not have been necessary if maintenance instructions had been followed. Engines have been returned to manufacturers for replacement of cracked cylinders caused by incorrect gasket material being used by field mechanics. In some instances gasket material was too thin, increasing the compression ratio; and some material was too thick and permitted the barrels to flex and crack when they were tightened into position. One report covered the installation of gasket material that overlapped between the barrel pilot and the crankcase, which made it impossible to pull the cylinder down tight into the crankcase.

Other cylinders that failed showed definite signs of detonation, due to either use of improper fuel, wrong size carburetor jets, improper use of mixture control, or the spark advance being too early. Had the manufacturer's recommendations been followed, not only would the replacement parts have been unnecessary, but loss of use of equipment, during the period of repair, would not have occurred. Some manufacturers have issued bulletins in which they recommend periods between engine overhaul; and in the majority of cases this will be between 400 and 600 hours. Frequently a top overhaul is recommended, in addition, at approximately 200 hours. We find that operators who are performing these overhauls as recommended by the engine manufacturer have less mechanical difficulty, buy fewer parts, and are able to keep their equipment in the air more consistently. Operators who follow manufacturer's directions are definitely able to save money.

The program of training in effect at present has made possible the establishment of an organization admirably suited to recognize and gather into one place knowledge of fundamental airplane "ills." This fund of information is available for interpretations which are important in the future development of the industry. They have shown that development must come with a considered coordination of the three musketeers—design, operation, and maintenance. Of these three, design is the more susceptible to constructive suggestions, but each of the three is equally important and care must be taken to insure that each shows progress. It is because of the manufacturer's ready cooperation and his promptness in helping to rectify troubles by issuing instructional bulletins to the users of his aircraft that we have stated that design is the musketeer most readily brought into line.

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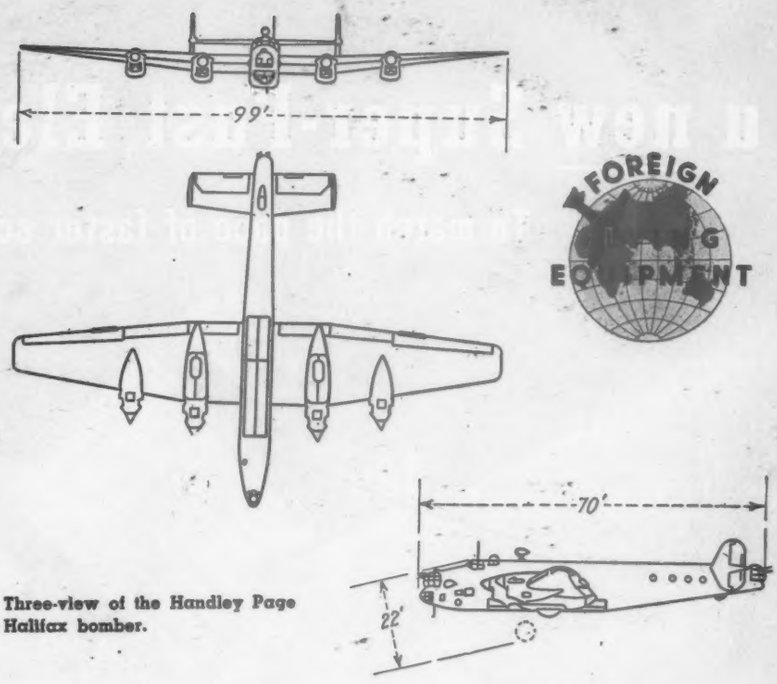
(Continued from page 105)

ceilings of aircraft attempting to intercept them. In fact, the ceiling of the Boeing Fortress is not actually known, for it will still climb above 40,000 ft., where atmospheric pressure is about 1/5 what it is at sea level (14.7 lb. per sq. in.), beyond which human endurance and ingenuity at present fails. Even the older models, which the British Purchasing Commission rejected early in 1940, had ceilings labelled 40,000 plus, for no one then, as now, knew how much higher they could go.

The reason for the exceptionally high ceiling for the Boeings is, of course, the turbo-supercharger developed by General Electric, which at altitudes above 20,000 ft. is superior to the mechanical type supercharger favored by the British. Moreover, although the average European bomber is not steady enough to drop bombs accurately at 20,000 ft., being confined to "regional bombing", our own Air Corps is said to have placed several bombs within a 25 ft. circle on the ground from a Fortress at that altitude. This stability, according to Eddie Allen, Boeing's flight engineer and a former Associate Editor of AVIATION, is entirely a matter of designing a bomber's tail surfaces.

Regarding the turbo-supercharger, it is interesting to note that the Stirling has an alternative power installation of Cyclone 14's which could be fitted with the General Electric turbo supercharger, thus giving the British bomber a higher ceiling than it otherwise could attain. However, installation of the Cyclones may be merely because the British have not yet got into quantity production on such aircooled radials, and need to augment their supply.



Three-view of the Handley Page Halifax bomber.

At any rate, whichever the case, it is unlikely the Stirling, with its greater weight and shorter wing span, could fly at the heights the Fortress will.

Needless to say, a cabin-heating arrangement has been incorporated in the British bombers, for at altitudes above 35,000 ft. the temperature is about 67 deg. below zero. The crew, also, quite likely wear electrically heated suits in case a shell fragment should let in the numbing cold of the substratosphere.

Judging from available reports, it would seem that the new British bombers have exceptional load-carrying capacity; greater, in the case of the Stirling, than that of the Fortresses now in service abroad, but having lower ceilings than the present Boeings. Lord Beaverbrook is quoted as saying that the "Flying Fortress is the most valuable and useful of all bombers . . . with all respect to the Stirlings, Halifaxes and Manchesters." Fortresses won't carry so heavy a load as some of their bombers, he said, but they will carry a load higher with a bigger measure of safety and a higher degree of efficiency.

Later Boeings, the B-17F's and others to be produced under the 500-per-month program, will have more defensive armament, greater bomb capacity, more armor for the crews, and radio locators for enemy aircraft, which should increase their effectiveness considerably.

But the steadiness at extreme altitudes beyond effective reach of AA fire and interceptor planes, which makes for accurate bombing, would appear to be a performance characteristic required in long range, heavy bombers if they are to carry out their missions efficiently. This characteristic the Boeing Flying Fortresses have, and possessed long before Britain became aware of its tactical value.

General Electric turbo-superchargers, shown here in assembly, make it possible for Boeing Flying Fortresses to climb higher than human endurance at present will follow by maintaining sea level pressure in the engines at high altitudes.